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See page 26

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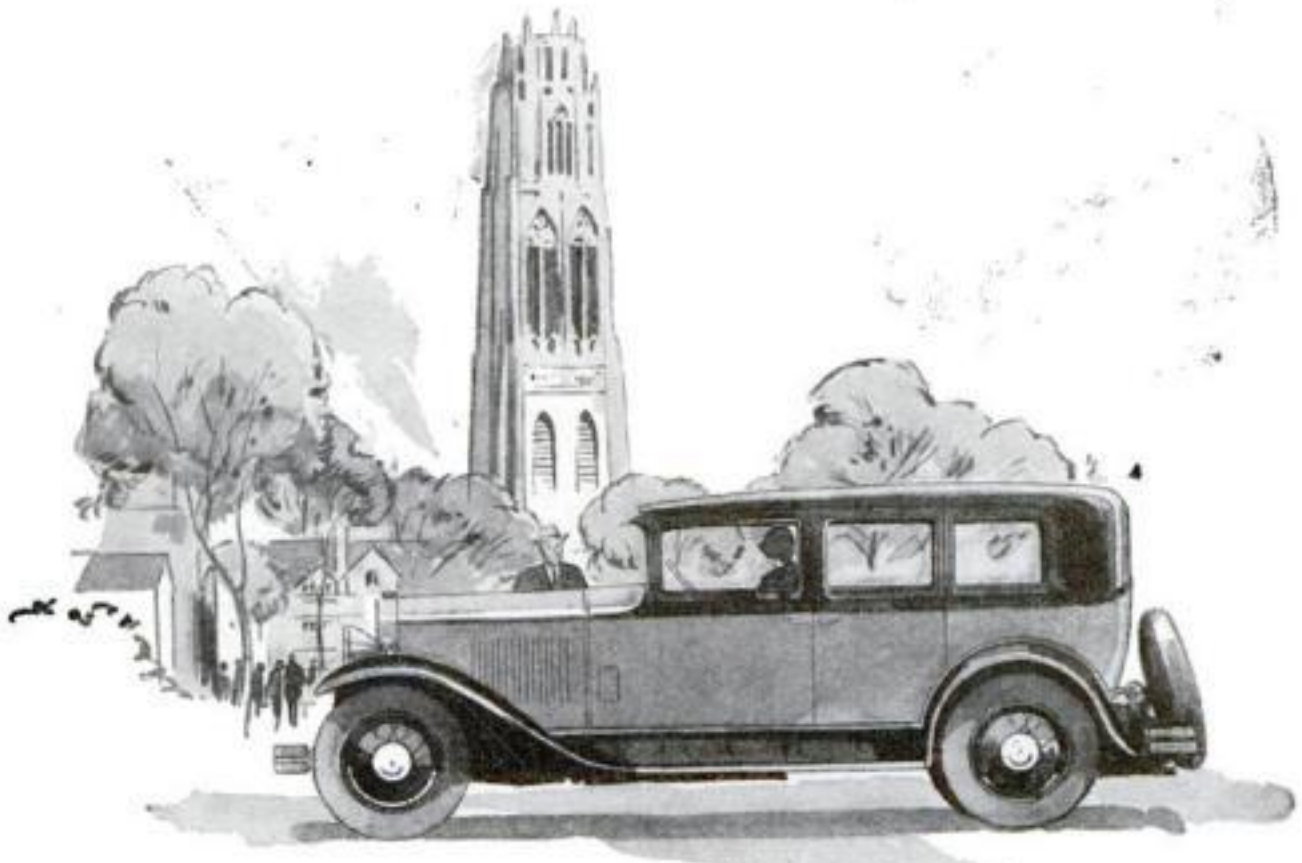

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How $680 a Year *Increased Craig Wright's Estate From* $12,000 *to* $42,000

By WALLACE AMES, *Financial Editor*

JEFF MARLEY was scared. With thoroughly justified fear he viewed the immediate financial prospects of himself and his family. And well he might.

No one could exactly accuse Marley of being improvident. He had worked hard—too hard for the good of his health. His family had lived comfortably, but modestly, so that Jeff had been able to accumulate enough money to buy an interest in the small financial firm of which he was vice-president. But his whole stake—all the money his family would have to live on in case of his death—was tied up in the future success of his business.

For two or three years Jeff Marley had seen the value of his investment in the business show a nice increase. As recently as October 1, 1929 he had remarked to his wife that their original investment of $5,000 had attained a value of $20,000. Both agreed that they were getting the breaks. Little did they realize the unfavorable developments which were just around the corner.

Early in October Jeff took to bed with pneumonia. During the stock market panic he was too sick to read the newspapers or get reports from the office. When he was finally able to return to work he found a strange and deplorable reversal of the conditions which just a few weeks previously had looked so rosy to him and his wife. The firm had escaped bankruptcy, but its orderly liquidation meant the cancellation at a total loss of the stockholdings of the operating executives. His job was gone; his income cut off; his estate wiped out.

THE fates had dealt an unusually jolting lesson to Jeff Marley. His narrow escape from pneumonia and simultaneous financial loss had driven home with too cruel force how fragile was the basis of the Marley family's financial welfare. So Jeff was haunted with a double fear. Where would he get a job? In the event of his untimely death, on what would his family exist?

"You never seem to worry."

"Why should I?"

With no attempt at disguise did Jeff Marley thus express his envy and admiration of the contented outlook on life held by his good friend and neighbor, Craig Wright. And since Craig was not one of those professional optimists . . . "just singing in the rain" . . . but on the other hand had good reason to view the future with contentment, his natural answer was "Why should I worry?"

"Why should you? A question more to the point is 'Why shouldn't you?'" suggested gloomy Jeff. "When we dropped in this evening you said 'Happy New Year.' But do you realize that you might get sick unexpectedly, just as I did, and you might not be fortunate enough to recover. But if you should recover, as I did, you might lose your job and your money in one fell swoop. Did you ever stop to consider what you would do if you were dealt the blow that struck me recently? Or what your family would do if a little germ bumped you off?"

The old adage "Misery loves company" is probably a more nearly correct explanation of Jeff's gruesome conversation than a desire to help Craig avoid difficulties similar to those that were preying on his mind.

"SURE, I have considered those possibilities," replied Craig, not in the least disturbed by the picture of possible horrors which Jeff had drawn for him. "I considered them long ago, twelve years ago, to be exact."

"Well then why don't you worry? You're not dumb enough to believe that your luck will go on forever."

"No, I am not that dumb. I am not trusting to luck at all, in fact. I am well protected against the contingencies that you have so cheerfully and so dramatically suggested."

"Protected—rats! No one could have been better protected than I was, but look at what happened. I was sitting on top of the world, but the top turned out to be a volcano, and when the eruption took place I fell right into the crater."

"Nothing you say changes the fact that I am well protected, so I should worry."

"If it is not too inquisitive may I ask *how* you are so well fixed to vanquish any unexpected misfortune?"

"I'll be glad to explain," replied Craig. "Perhaps my plan will be of some help to you. It is not patented. You are welcome to work the same plan if you like.

"When I reached my 28th birthday I had saved $1,000. At 5½% this paid me $55 a year. I took out a $3,000 life insurance policy on which the yearly premium deposit was $56.70. The income from my investment was reserved to pay for the insurance. Thus I immediately increased my estate from $1,000 to $4,000.

"Then I established a fixed policy of saving a reasonable portion of my earned income each year (Continued on page 5)

How $680 a Year Increased Craig Wright's Estate From $12,000 to $42,000

(Continued from page 4)

and at the end of the year invested it in securities. I did not put my savings in speculative securities, but was influenced entirely by safety considerations. On an average my investments have returned 5½% income and from year to year I have taken out as much additional life insurance as that investment income would pay for.

"In the beginning my salary was $3,000, of which I saved and invested $500. Each year I got a moderate salary increase. Up to age 35 I managed to save about 16% of my earned income. From then on, when my salary was $5,000 a year or higher, I saved and invested a little over 20% of it. Up to my last birthday, when I was 40 years old I had saved $12,450 out of earned income. My series of life insurance policies now total $29,500. So the present value of my estate is $41,950.

"INCOME from $12,450 at 5½% amounts to $684.75; the total amount of my life insurance premium deposits, at the rates at which I took out the several policies, is $680.61. So the one almost exactly offsets the other.

"That, by the way, is one of the many interesting little side features of my plan. Everyone I know has to scurry and scrape to meet his insurance payments. It seems to be popular practice for policy-holders to let their insurance agents carry their payments for two or three months after they become due. Or to pay the insurance companies with notes. Obligations that come due at regular, but unfrequent intervals seem so hard to meet. Lack of preparedness in this respect seems to be a trait of character with all salaried persons. Personally I have never been annoyed over the receipt of premium notices. I just clip a bond coupon or cash a dividend check and pay the money over to the insurance company. All I have to do is to save a regular amount out of each salary check. The rest of the system runs itself.

"HAVE I answered your question, Jeff, as to why I do not worry over future misfortunes which may some time overtake me?"

"Yes," replied Jeff, "and more. You have put a real idea into my head. I am glad your system of estate-building is not patented. Even if it was I would be willing to pay a royalty to be able to use it."

Based on the Craig Wright method of providing substantially for his family, we have compiled a simplified table to show just how the plan would develop from year to year. The table is presented with this article with the following explanatory comments.

First we assume that Craig Wright earned $3,000 during the year ended on his 28th birthday, and that beginning on his 28th birthday he had $1000 invested at 5½%. Then we allow him a normal yearly increase (Continued on page 6)

How $680 a Year Increased Craig Wright's Estate From $12,000 to $42,000

(*Continued from page 5*)

in salary and estimate his future yearly savings according to his statements to Jeff Marley. We ignore all irregularities, such as market profits or advancing values in his security holdings, extra dividend disbursements, etc. and assume that his investment income was exactly 5½% of the amount saved and invested each year. Thus the first three columns of the accompanying table give the basis of working out the possibilities.

The form of insurance figured on is Ordinary Life. So as not to complicate the calculation we have ignored the factor of policy dividends. In a term of years these would aggregate a considerable sum, which could be used to reduce the net premium deposit, or buy additional insurance. Because of the way insurance rates are figured it is not possible to match up premium deposits and investment income exactly, but in the table the difference between one and the other is always negligible.

ACCORDING to our computation Craig Wright earned $61,000 between ages 28 and 40. Whereas he saved only about 20% of this the total value of his investment-insurance estate is nearly 70% of his total earnings. It is entirely probable that any man who operated the Craig Wright plan over a period of years would be better off financially than our computation shows, for either or both of two reasons: Properly selected securities will gain value; policy dividends would improve the result.

Trust companies now operate insurance trust departments, rendering to individuals just such a service in estate-building as Craig Wright worked out for himself. You may deposit income-bearing securities with a trust company and they will attend to all the details for you. Or, if you have not yet acquired the securities you can start now to get them, a little at a time. It is amazing how rapidly you can make your estate grow, safely, if you just work some such plan as Craig Wright's.

Buying an Estate of $41,950 With the Income from $12,450

Age	①Yearly Salary	②Salary Savings Invested at 5½%	Yearly Income from 5½% Investments	Annual Deposit on New Insurance	Yearly Amount of New Insurance	Total Insurance to Date	Total Investments to Date	Total Value of Estate to Date
		③ $1,000	$55.00	$56.70	$3,000			
28	$3,000	500	27.50	18.90	1,000	$4,000	$1,500	$5,500
29	3,250	500	27.50	29.12	1,500	5,500	2,000	7,500
30	3,500	500	27.50	29.91	1,500	7,000	2,500	9,500
31	3,750	600	33.00	30.77	1,500	8,500	3,100	11,600
32	4,000	600	33.00	31.65	1,500	10,000	3,700	13,700
33	4,250	750	41.25	32.60	1,500	11,500	4,450	15,950
34	4,500	750	41.25	44.78	2,000	13,500	5,200	18,700
35	4,750	750	41.25	46.20	2,000	15,500	5,950	21,450
36	5,000	1,000	55.00	47.68	2,000	17,500	6,950	24,450
37	5,500	1,000	55.00	61.55	2,500	20,000	7,950	27,950
38	6,000	1,500	82.50	76.35	3,000	23,000	9,450	32,450
39	6,500	1,500	82.50	78.99	3,000	26,000	10,950	36,950
40	7,000	1,500	82.50	95.41	3,500	29,500	12,450	41,950

①Earned during year ended at given age.
②Approximating 16% of earnings each year ending at age 35 and 22% thereafter.
③Amount previously saved so plan becomes effective at 28th birthday.

(*Continued on page 7*)

How $680 a Year Increased Craig Wright's Estate From $12,000 to $42,000

(Continued from page 6)

In addition to the table which shows how Craig Wright built up an estate of $41,950 by using his investment income to carry life insurance, there is also appended to this article a table of ordinary life rates on the 3½% reserve plan for men of various ages. Referring to this table and taking into consideration your present salary and possible savings schedule, you can easily determine the value of the estate you might create by working the Craig Wright plan.

May we suggest that you do just that. An evening spent with pencil and paper will reveal some startling and stimulating possibilities growing out of a practical combination of investment and life insurance. And what easier way could you find to carry adequate insurance protection than by paying premiums with your investment income.

When you have finished your own figuring we suggest that you consult an insurance adviser. Describe your plan to him and he will doubtless help you to adjust the details to your greatest advantage. He can point out many possibilities not within the scope of this article.

Ordinary Life Rates
3½% Reserve

Situation at age 40

Total Investments	$12,450.
5½% Income from Investments	$684.75
Total Insurance	29,500.
Total Annual Insurance Deposits	$680.61
Total Estate	41,950.

Age	Annual Premium	Age	Annual Premium	Age	Annual Premium
25	$17.52	32	$21.10	37	$24.62
28	18.90	33	21.73	38	25.45
29	19.41	34	22.39	39	26.33
30	19.94	35	23.10	40	27.26
31	20.51	36	23.84	45	32.89

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

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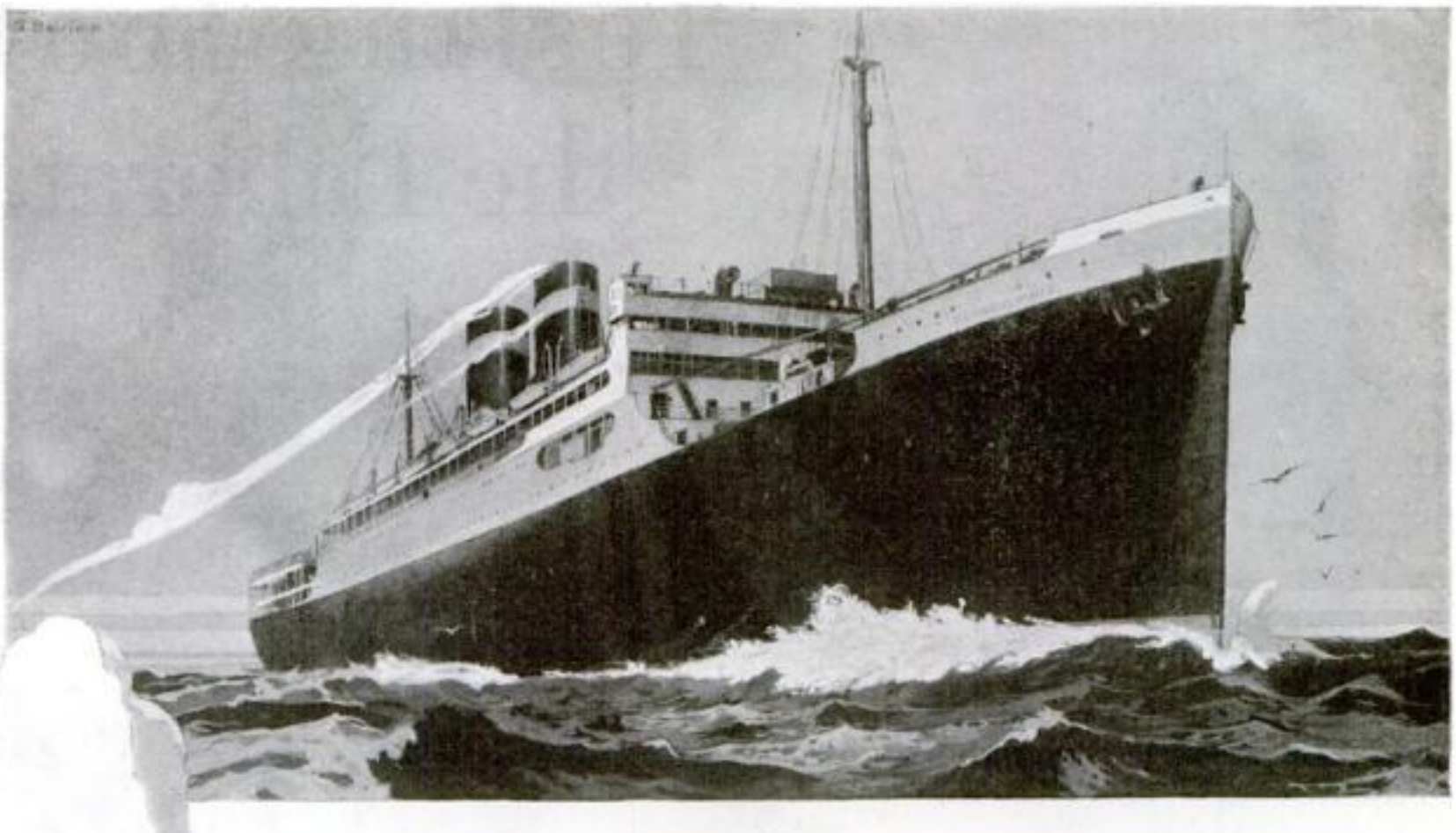

The combined tonnage of Admiral Dewey's fleet in the battle of Manilla Bay was 19,000 tons—less than the tonnage of the *Pennsylvania* or her sister ships, the *California* or the *Virginia*, the new electrically driven vessels in the service of the Panama Pacific line.

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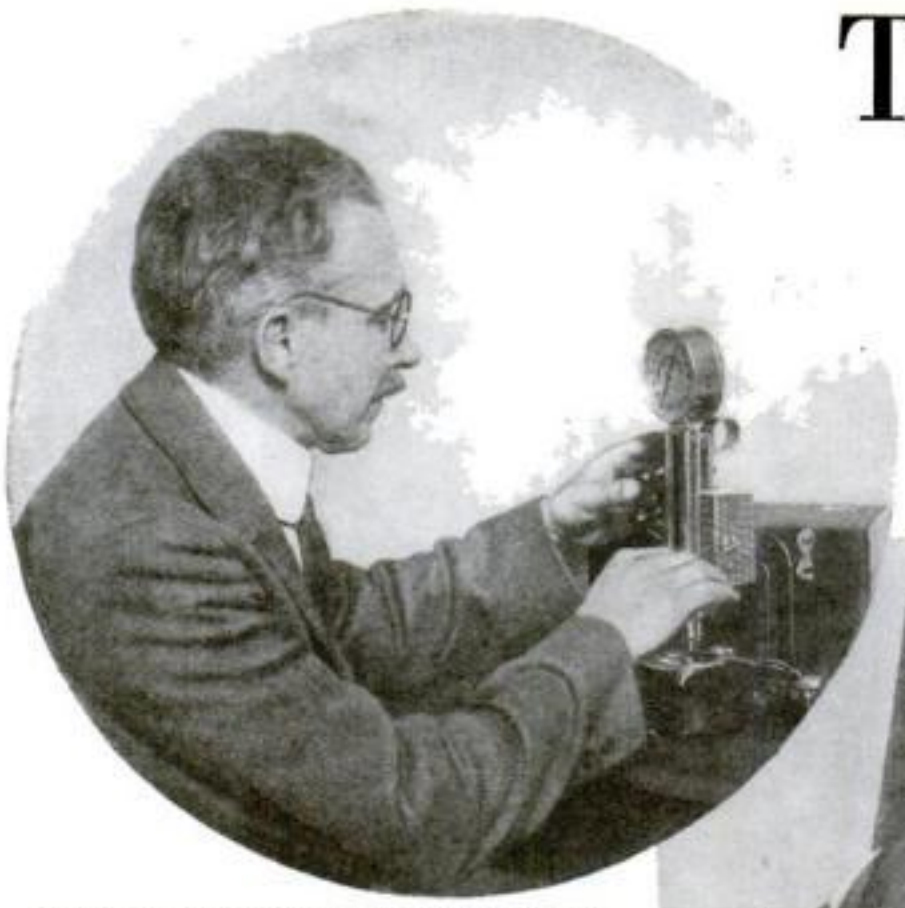
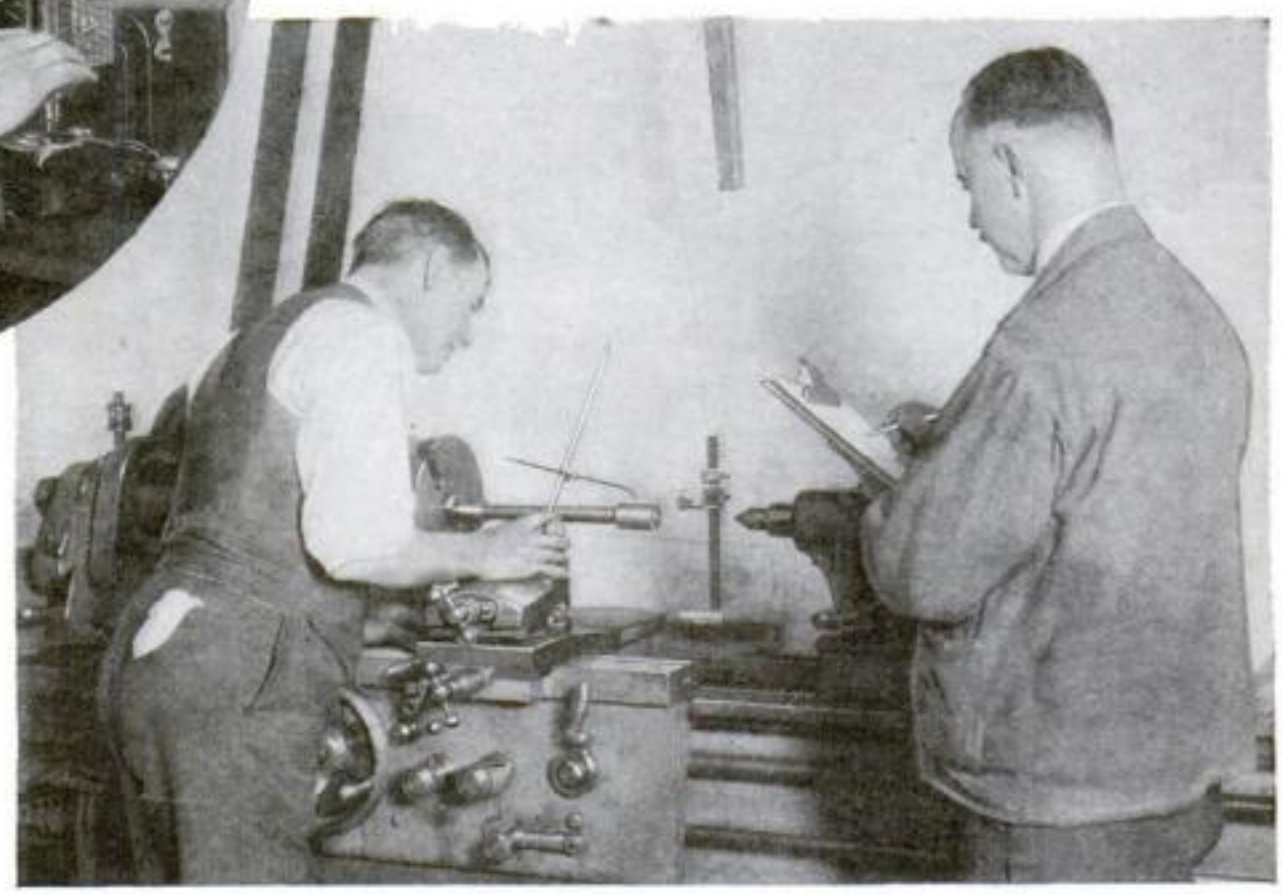
Testing Tools in the Laboratory

By COLLINS P. BLISS
Director, Popular Science Institute



Measuring the hardness of the steel in a pair of pliers. The instrument used is the scleroscope.



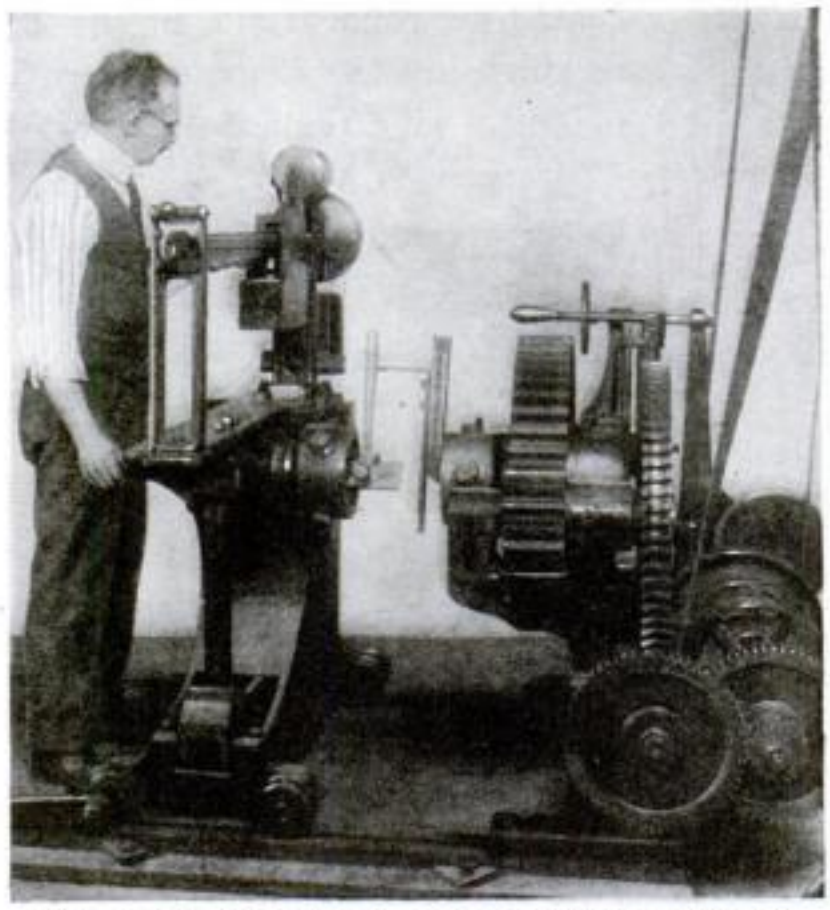
Testing the spindle of a lathe for parallelism in the laboratory of the Popular Science Institute. Forty different points of inspection are covered in the testing of an ordinary screw cutting type of lathe.

THE equivalent of years of every-day wear is given in a few minutes to tools undergoing tests in the laboratory of the Popular Science Institute. Some of these machines seem almost human in their movements and tell accurately facts that years of usage would only partially disclose.

One of the most interesting of the testing devices is the torsion machine, shown at the bottom of the page. It tells three important things about a hammer. It determines the strength of the claws, it tells how well the hammer head is fastened to the handle, and it establishes the quality of the wood in the handle itself.

As the engineer looks on, a mechanical hand two hundred times stronger than a human hand pulls the handle of the hammer, whose claws clutch the head of a heavy wire nail. The nail itself is clinched to the bed of the machine. A dial, which the engineer is shown reading, measures the strength of the hammer's claws. Then, after certain other tests have been made in different machines on the head of the hammer, the tool is once more placed in the torsion machine. This time the mechanical hand pulls on the hammer handle while the tip of the claw clutches a steel bolt. As the bolt is embedded in a steel plate and cannot let go, the hammer handle breaks. The amount of load the handle will withstand before breaking is accurately registered and must meet a certain predetermined point if the hammer is to be approved by the Popular Science Institute.

The two men in the photo above to the right are testing the spindle of a lathe for parallelism. In all, there are some forty points of inspection on the ordinary screw cutting lathe, while a still greater number must be checked in the case of lathes with special attachments and accessories. Several testing bars—like the one shown in the headstock of the lathe illustrated—are used in this particular testing process.



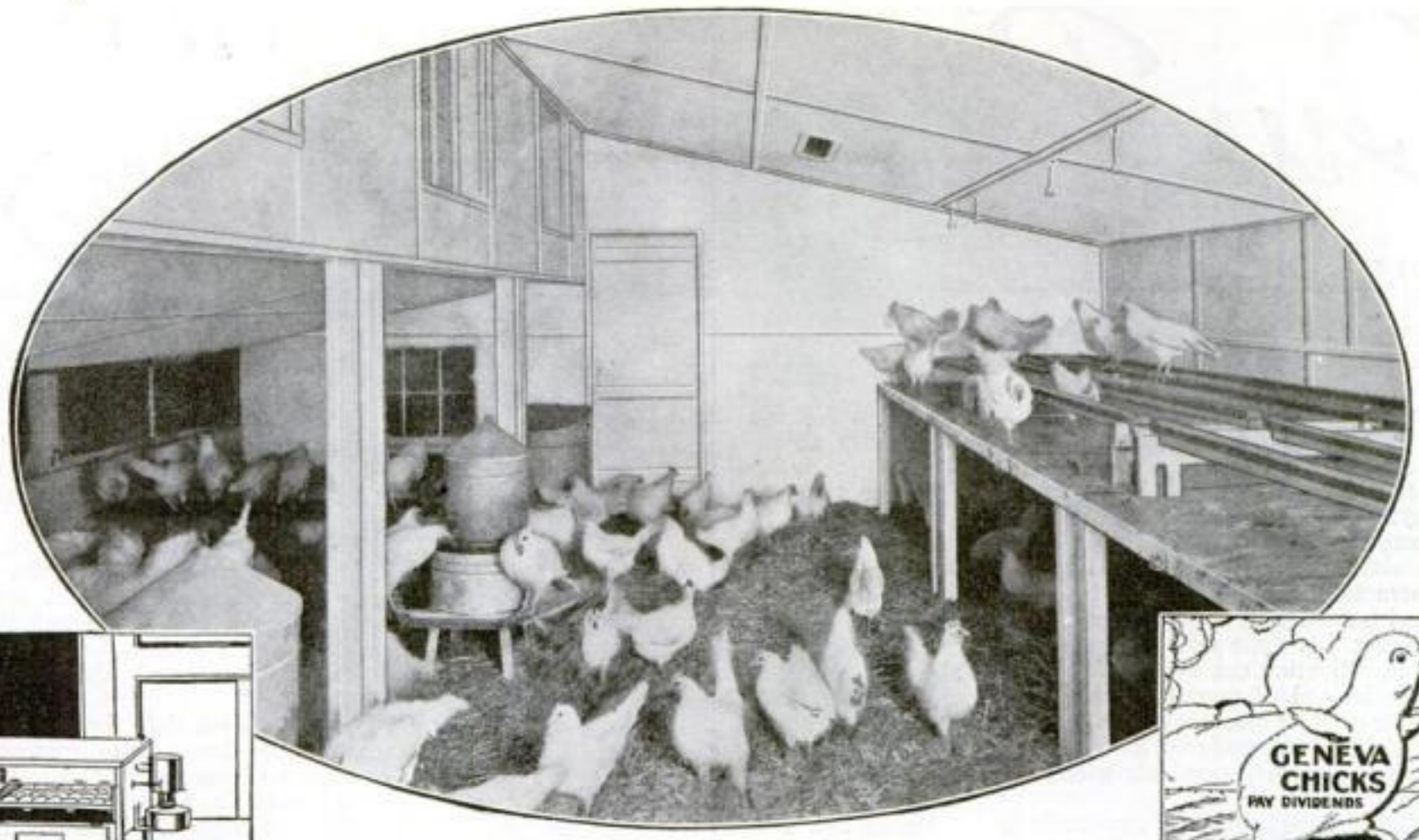
The strength of the claws of a hammer is recorded on the dial of this testing machine, which can exert tremendous force.

The degree of hardness of the steel is an important point to be considered in the case of most tools, and the scleroscope, shown in the circle at the top of the page, definitely establishes this point. At the time the picture was taken, a pair of pliers was being tested. In testing, the cutting edge is clamped to the anvil of the machine by the revolving wheel at the left. A diamond pointed plunger released by the operator registers on the dial the intensity of the blow. This is a measure of the hardness of the material. In the case shown, the scleroscope number was eighty—which is a very excellent figure.

THE tests described here give an idea of how Popular Science Institute finds out the essential facts regarding a tool before reaching a decision as to its merit. When the approval of Popular Science Institute has finally been granted to any tool, it means that it is well made of proper materials, represents good value, and is capable of giving satisfactory and lasting service. Full reliance, therefore, may be placed on tools advertised in POPULAR SCIENCE MONTHLY, all of which carry the Institute seal of approval.

* *

Readers may obtain a complete list of all tools that have passed the tests by applying to Popular Science Institute, 381 Fourth Ave., New York, N. Y.



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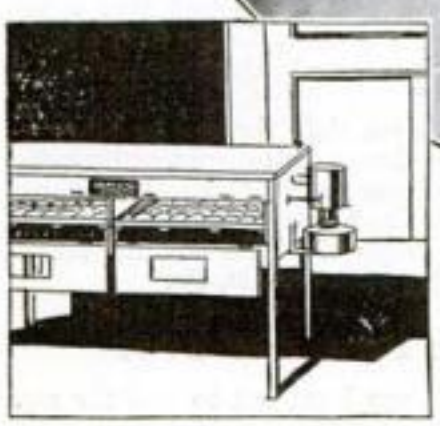

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For signs and cut-outs

They hatch 'em—raise 'em—sell 'em with PRESDWOOD

In Racine, Wisconsin, a big manufacturer of incubators finds that Masonite Presdwood gives his product great strength, withstands moisture, is naturally attractive in appearance, and requires no paint for protection. On a Missouri farm, an expert poultry raiser uses this same grainless wood on hen house floors and under roosts, because of its smooth sanitary surface which is so easily cleaned.

Withstands the weather

In Kalamazoo, a sign manufacturer makes attractive cut-outs which advertise baby chicks, and finds Presdwood ideal for his purpose. It does not crack, split or splinter; is easily cut to shape. It withstands the weather, takes any finish readily, and does not warp when properly handled.

And so it goes in hundreds of industries and in thousands of home workshops where Presdwood has been adopted because of its many advantages.

Factory experts, operating punch presses, milling machines or band saws, like Presdwood for its workability. It is strong and dense, yet easily cut. It can be worked with knife or chisel or saw, and can be nailed near the edge without splitting. Always the same in strength and density, Presdwood adds quality and dependability to manufactured items. Makes manufacturing more profitable, too, because of the way this grainless wood cuts down costly rejections in final inspection.

Contractors, handling concrete work, use Presdwood to line the forms because of the thousands of dollars it saves. Its lighter weight cuts down drayage costs. Its workability reduces the time of making, erecting and wrecking the forms. Its perfect smooth surface eliminates all grain and knot marks, and produces a superior surface that requires no hand smoothing except at construction joints.

Masonite Structural Insulation

Presdwood's companion product, Masonite Structural Insulation, was used in the walls and roof of the hen house above illustrated.

It was used to save fuel, to reduce the feed needed in the generation of body heat, to keep the hens warm and healthy in order that egg production might be kept at a maximum during the winter.

The Presdwood booklet is Free

No wonder builders, home owners and manufacturers everywhere are turning to Presdwood. The complete story of this grainless wood, with illustrations of its uses, is in the Presdwood booklet which is sent Free on request. Your copy will be mailed promptly on receipt of the coupon.

MASONITE CORPORATION
111 West Washington Street Chicago, Illinois

MASONITE CORPORATION, Dept. D-3 111 W. Washington St., Chicago, Ill.
Please send me, Free, a sample of Masonite Presdwood and the Presdwood booklet.

Name.....

Address.....

City..... *State*.....

Masonite
PRESDWOOD
Made by the makers of
MASONITE STRUCTURAL INSULATION

Our Readers Say

From a Famous Engineer

I SHOULD like to call your attention to an article in your publication for January, 1930, pages 17 and 129. This article refers to "street noises," and dismisses the most serious street noise with some remarks that are not correct. I refer to the noise of riveting machines, in steel buildings.

Your article states that it will be premature to do anything regarding this, and that in time it may be replaced by welding. I do not agree with either one of these statements; and as a structural engineer who has had both bridges and buildings in charge, I would say that to correct this noise would be rather an easy matter. Riveting can very well be done by pressure instead of percussion machines. An hydraulic riveting machine can be installed at a very slightly increased cost, as well as air machines, run by compressed air without a percussion effect.

Such machines are being used constantly in shops where bridge and other steel members are being manufactured, and there is no reason whatever why they could not be used in buildings, except for their slightly increased weight, and for the fact that in some cases special machines might have to be made. This latter objection, however, might in a great measure be removed by care in design of the structure, so that such machines could be applied. Very truly yours, Ralph Modjeski, New York, N. Y.

Ralph Modjeski is one of America's foremost bridge engineers. He is best known for his work as chief engineer of the great Philadelphia-Camden bridge across the Delaware River, and as one of the engineers who built the famous Quebec cantilever bridge across the St. Lawrence River.

A Ventriloquist, Maybe

I ENJOYED Martin Bunn's article, "What Horsepower Really Is," but I am puzzled to know how Gus, the auto sharp, managed to talk continuously and eat his lunch at the same time. At the beginning Gus is described as having "his mouth too full of ham sandwich for articulate expression"; yet he never stops talking and we find him at the end "sweeping the crumbs off the table into his lunch kit," which indicates that the lunch actually was consumed while he discoursed so learnedly on measuring mechanical power. Even if he could do it, so wise a man should know better. Certainly his mother taught him that it's not nice to talk with your mouth full of food.—P.M.O'H., Wilmington, Del.

Saved His Life

COMING June will mark three years since I went to a hospital, from which I was not expected to come out alive, but I pulled through in time and while convalescing started to make a Spanish galleon. That work really saved my life as it kept me occupied and I forgot all about my misery. I never will be able to follow my former occupation, but during all my time at home I became very well acquainted with Captain McCann's ideas and his skill as a sailor. I have built all the ship models you published the plans for, with the exception of the "Constitution" and sold four of them. I am nearly sixty years old and I believe there are more men of my caliber—a little lazy in writing letters, but, nevertheless enjoying your articles tremendously.—J.K., Stapleton, N. Y.

That Automobile Speed

WELL, I certainly was surprised when I sat down to work out your little problem about finding the average speed of an automobile that traveled one lap at ten miles an hour and the second at fifty. I'd have said "thirty" right off if I hadn't been told that was wrong.

Here's how I did it. I supposed the track was fifty miles long. Then it would take the auto driver five hours to cover the first lap and one hour to cover the second. Total, six hours. Total distance (two laps), 100 miles. Average speed, 100 divided by six. Answer, 16⅔ miles an hour average speed. Sounds unbelievable, doesn't it? I tried it again with another distance, but it doesn't matter; you could call it X and solve it by algebra. The trick is simply that the problem gave distance—"one lap"—instead of time. If an auto traveled for *one hour* at ten miles an hour, and another *hour* at fifty, of course the average would be thirty.

And, by the way, that little problem certainly shows how a bit of bad road will cut down your average speed when you go touring. —F.B.H., Cambridge, Mass.

Chemistry vs. Physics

IN YOUR interesting survey of "What Science Achieved in 1929" I seem to sense a battle brewing between the cohorts of chemistry on one hand, and those of physics on the other.

Thus, in reviewing the progress of chemistry during the year in your magazine, Dr. Hugh S. Taylor, Professor of Chemistry in Princeton University, says:

"The discovery by Giauque, Johnson, Birge, and King of two hitherto unsuspected isotopic forms of the elements oxygen and carbon, by an analysis of their spectra, constitutes another notable advance."

And in the very same column, under the heading "Physics," appears this from Dr. Paul R. Heyl, Physicist of the United States Bureau of Standards:

"In atomic physics there have been discovered two new modifications or isotopes of oxygen and one of carbon. *These discoveries are claimed by physics, as they were made by physical methods.*"

Sounds almost like two heavyweight pugilists squabbling over the right to the world title.

Here is just another instance of how modern discoveries of universal forces are tearing down the fences that once divided so neatly the various fields of scientific research. I have just read a statement of Dr. Irving Langmuir, famous chemist of the General Electric Company, that is right to the point.

"Physics and chemistry are being inevitably drawn closer together," says he. "Unfortunately, although theoretical physics and chemistry are . . . being merged into a new science, there are remarkably few men as yet that have received adequate training in both sciences."

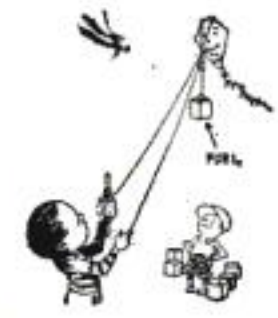
It seems to me that the sooner other big men of these sciences quit disputing boundary lines that no longer exist, and instead devote themselves to this broader training, the better it will be for progress. What do other readers think?—J.L.K., Philadelphia, Pa.

We Pass the Test

SIX months ago I set out to find the most interesting, modern, and authoritative science magazine published and therefore I had delivered to me *17* different magazines per month. After this six months' trial, during which period I studied every copy and took note of their articles, illustrations, advertisements, set-out, printing, and paper, I came to the conclusion that P.S.M. was well ahead of them all. When I tell you that I had copies of America's and England's foremost scientific magazines, I think that this fact stands for itself.—J.L.A.R., Hinaidi, Iraq.

All Ready for the Great Kite Flying Controversy

I NOTICED your article concerning a world's record for kite flying. This unofficial record was said to be twenty-two hours and twenty-one minutes. I hate to argue about such a small matter, but when a world's record is thrown in it is a different thing. I have many witnesses to prove that on Friday, February 18, 1907, Tom Moran and myself, while at boarding school, put up a kite at eight o'clock in the morning, and it stayed up until Sunday night at six-thirty. I think if you figure that up it will come out at fifty-eight and one half hours. At that time no other man, airplane, or kite had stayed up more than fifty-two hours. At that time we did most anything with a kite, from ordinary kite flying to fighting with other kites.

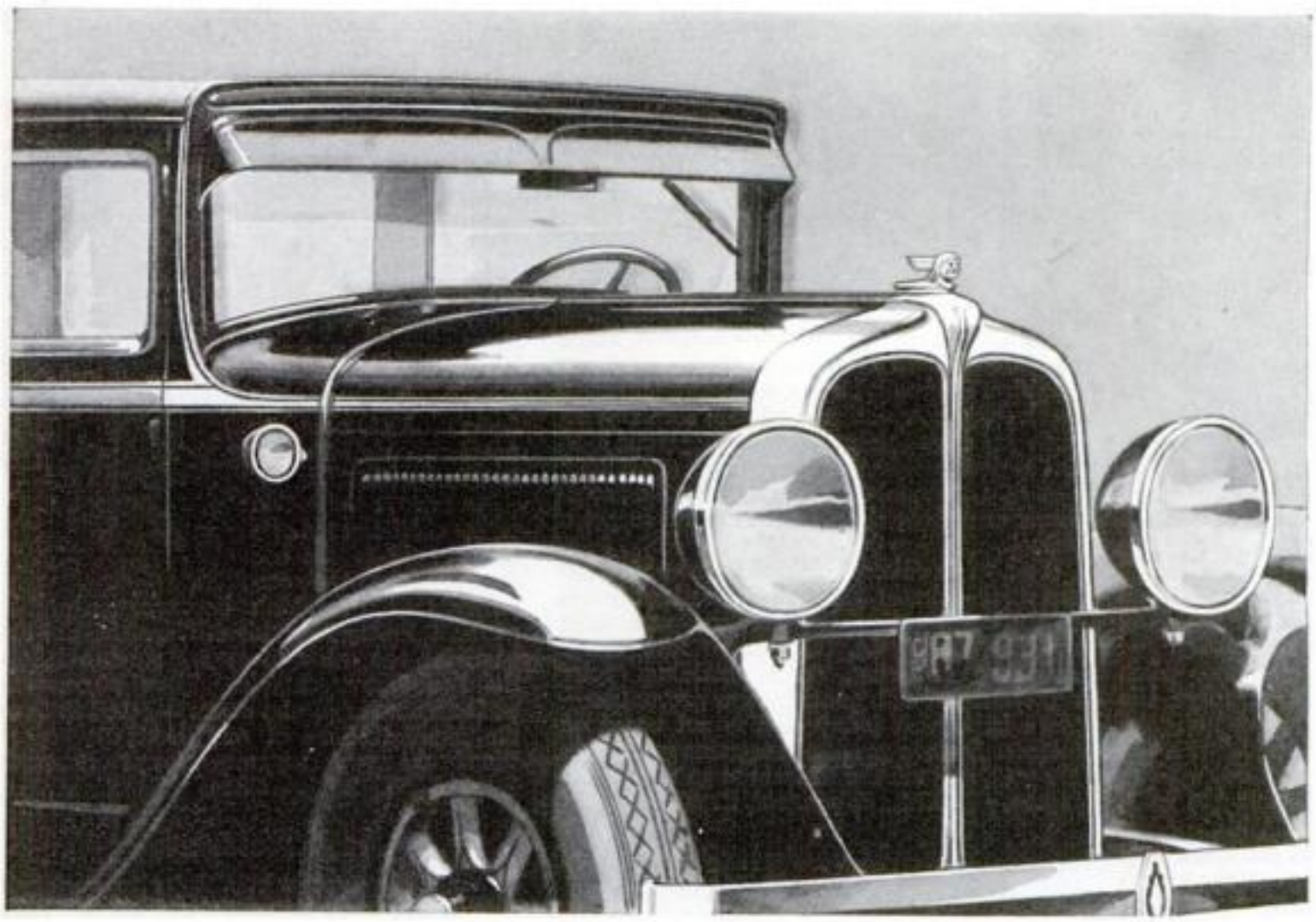


I wish you would look into this and see if we are any ways near a world's record, although I believe other kites have stayed up longer.—T.A.D., Detroit, Mich.

Meteoric Matrimony

LAST night I was sitting at my desk reading your little book, "The Pocket Guide to Science." In the chapter on the "Story of the Stars" I read this: "Do We Need to Be Afraid of Falling Stars?", and the following discussion: "No. The chance of one hitting anybody is less than one chance in a great many billions. There

There is *New Mechanical Excellence* in this finer Pontiac



PONTIAC has always been held in high favor by motorists interested in mechanical details. This is especially true of the newest Pontiac—the New Series Pontiac Big Six. For, in addition to offering all of the features of big car mechanical excellence which characterized its predecessors, this finer Pontiac offers many important improvements.

There is the increased smoothness of its 60-horsepower, L-head engine—the result of new-type rubber engine mountings which insulate the engine from the frame. Its big, dependable, internal four-wheel brakes have been made still more effective. A new steering system, which acts on roller bearings, contributes added handling ease. A more efficient type of starting motor, semi-automatic and manually controlled prevents chipping of the fly wheel gear teeth. The lateral rigidity of the crankcase has been strengthened to reduce crankshaft distortion to a minimum. And so on all through its chassis you find similar examples of improved design.

But don't be satisfied just to read this brief statement of what the newest Pontiac offers. Go and see the car today. Arrange for a real test out on the road. That is when you will learn why we call the New Series Pontiac Big Six "a finer car with a famous name."

Oakland Motor Car Co., Pontiac, Michigan

Write for an interesting booklet which illustrates and describes the design of the New Series Pontiac Big Six

NEW SERIES PONTIAC BIG SIX

PRODUCT OF GENERAL MOTORS

is no record of any one ever having been hit."

As I laid aside the little book and picked up the daily paper to scan it, the first thing that caught my eye was this heading: METEOR KILLS TWO AT WEDDING PARTY. Accordingly, under the chapter on falling stars in the pocket guide I suggest a revision of the query and answer to the following: "Do We Need to Be Afraid of Falling Stars? *Only in the Case of Matrimony!*"—E.A.T., Columbia, Tenn.

—And the Good Old Ashes

WHY not get a man who is an authority on anthracite coal to write you an article on coal as a fuel? I've read the article on oil as fuel, by Mr. Bliss. In one place he tells you oil users would pay 100 percent more for oil before they would go back to coal. Does he know that recently a man from the New England states said that he would never use oil if he could obtain a steady supply of good old anthracite? With the assurance of no strikes in the future, and a steady supply of coal, there will never be the time when oil will scrap the coal shovel. Me for anthracite, the good old clean, safe, silent fuel.—S.B.M., W. Pittston, Pa.

The Cat Walk—It's a Gift

PERHAPS some of your readers who are interested in "heredity" of humans (and cats) may be interested in the following.

We had a black female cat who, when hungry, would run alongside of those she knew, running on three legs, and tapping the foot of the person she was following with one of her forepaws. One of her kittens, a black tomcat, now about a year old, does the same thing.

As the old cat died when this cat was a very small kitten, it can hardly be attributed to imitation, and must apparently have been "handed down" in the brain cells as a characteristic. I have never seen any other cat do the same thing, that is to say, any full grown cat.—C.L.W., Sykesville, Md.

Meeting Human Needs

IF YOU ask me, the best thing in your January number was a little picture on page seventy-three, showing an apparatus that meets the well-known "long-felt need." A device permitting a man to breakfast and read in bed in comfort is something I have vainly sought for many years, each of which included fifty-two Sunday mornings marred by its lack.

The word "man" is used advisedly. In your presentation of the novelty you made two mistakes. First, it was poor policy to show a girl using it, for if women are encouraged to eat and read in bed, who will cook the Sunday breakfast? Secondly, you spoiled things somewhat by emphasizing the gadget's usefulness in the sickroom. Doubtless it will prove a boon to invalids, but the thought will not down that there was something Puritanical about this insistence and that you cling to the deplorable notion that leisure and comfort interfere with the soul's salvation.—P.E.F., Philadelphia, Pa.

One from Australia

EACH fresh number of your magazine is eagerly anticipated and I am pleased to say that I have never experienced disappointment with any of them.—B.B.L., Sydney, Aus.

A Hero to Our Rescue

"I DO not like any of the articles that you publish in your magazine. If you do not leave everything out I will quit taking it. Confine your magazine to the two covers and the advertisements, and you will publish a magazine that is worth reading."

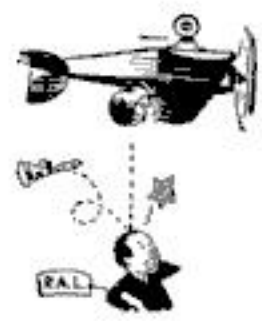
Now wait a minute, Mr. Editor. That is not my sentiment at all. But if you combine the substance of all the "kick" letters that you receive, is not the above the sum of their complaint? Some say "leave this out"; others want "that left out." Some say "there are plenty of other magazines to publish this and that." Of course there are. But is that any reason why it should not be published in P.S.M.? Perhaps some of us do not take those other magazines, and then we would miss a lot of mighty good reading.

Of course there are some things in your magazine in which I am not interested. But I am not asking you to leave them out. Some one is interested in them, or they would not be there. It would be just as foolish for me to go to my grocer and say, "I will stop trading with you if you do not stop selling peas; I do not eat them, because they roll off my knife." But other people eat them, and so the grocer keeps on selling them, and tells me to get a shovel.

You, as an editor, know what to put in your magazine. Almost anything interesting appeals to the intelligent reader. As for some articles not being scientific, there is no such thing. Aviation, motoring, model building, polar exploration, fossil hunting, fire prevention—there is nothing today that is not based on science. So keep your fine magazine going as in the past, and tell the whiners to go to—Washington.—E.B.M., Bakersfield, Calif.

Is He Right?

IN DEFENSE of your writer, whom R.A.L. challenges: The writer is very conservative when he states that two thirds of the lift of a plane's wing is obtained by the vacuum on top. Some experts say that it's three fourths of the total lift. As to Mr. L.'s statement that if this is so the plane flying upside down should fall, there is this to be said: When flying upside down the plane is slightly tilted, the nose high, thus increasing the degree at which the wings strike the air (the angle of incidence). As this is increased until it reaches about sixteen degrees, the lift also increases. This angle forms a vacuum on top and destroys the one on the bottom which the camber (curve) tends to make.—L.B.S., West Hartford, Conn.



Profit in "Fixing It"

I'VE read POPULAR SCIENCE MONTHLY for many years, beginning in 1916 or 1917. Then I used to buy them at the news stands but lost out on so many numbers that I am a subscriber now. I have made many articles I found in P.S.M. and am very well pleased with them.

Your "Fix It Yourself" book and the "Pocket Guide to Science" are wonderful. The "Fix It" has saved me the price of POPULAR SCIENCE MONTHLY many times this summer on the house and furniture.

I like the Home Workshop section of your magazine the best, but would like more articles relating to repairs in and around the home, toys, etc., for I have not the time to make the ship models. However, I am only one of your readers and you have to please thousands, so if I do not get what I want I shall not complain.—I.C.E., Asbury, Mo.

Going One Better

I AM well pleased with P.S.M., expecially with the article "Solo Flying for Young Aviators," by Charles A. King, in the January issue. But I went a little further than he did and mounted a small electric motor in the plane, and had this controlled by a small transformer which in turn was connected to a "throttle." With this arrangement you can control the speed of the motor. Maybe some other air-minded readers would care to try this.—R.M., Center, N.D.

Some Simply Don't Answer

FAR be it from me to join M.O.R. in decrying scientific progress, but I confess I was dismayed by the news that the *Leviathan* had installed a regular ship-to-shore telephone service for its passengers. Nautical newspapers and radio communication we have had for some time, and lately full-fledged brokers' offices made their appearance aboard ocean liners. And now the telephone furnishes the last link with land.

And such a link! One of the chief charms of a sea voyage to me has always been the certainty that I couldn't be "wanted on the phone." Pretty soon this will be a thing of the past, for the other liners are sure to follow the *Leviathan's* example. Then where is a business man to go who wants to get away from the manifestations of our hectic existence? What do you suggest—Mount Everest?—L.N.McB., Boston, Mass.

In a Nutshell

E. B.R. surely speaks a huge mouthful of truth, when he says we're all one huge family. I am just another of the Huge Family that enjoys the POPULAR SCIENCE.—J.J.N., Pasco, Wash.

Paus sure can paint good pictures. Here's hoping he may paint many more of your covers.—A.L.R., Watertown, Wis.

I think P.S.M. is the best of all scientific publications. By all means keep up the Home Workshop and Back of the Month's News.—J.D.F., Carlisle, Penn.

I thoroughly enjoyed the article on psychology in the December number. Let's have more of them.—G.V.H., Springfield, Ill.

POPULAR SCIENCE MONTHLY has kept me up to date on science and inventions, which I must say hold my interest. I hope that your magazine for the coming year will be as interesting as it has during the past year.—L. van M., Forest Hills, N. Y.

And the Soup Inhaler?

NEW YORK'S anti-noise campaign, so vividly described by E. E. Free, is one of the most urgently needed civic crusades ever to come to my notice. The arrogantly barking auto horn, the nerve-wracking riveting machine, the rumbling truck, the grinding trolley car, and the bellowing street loudspeaker must be muted. This accomplished, the committee might concentrate on muzzling the talker, candy-unwrapper and program-rustler in the theater; the drink-and-tell-all antiprohibitionist; the travel-broadened returned European tourist; the surgical operation survivor, and the stock market winner and loser.—B.A., N.Y.C.

"That sore throat'll be *gone* by morning"

SORE throat is a warning to look out for a cold—or worse.

If you have the slightest indication of trouble, gargle immediately with full strength Listerine. Keep it up.

Millions have found that this simple act checks the ordinary kind of sore throat promptly. Keeps it from becoming serious. Moreover, they have proved that its systematic use is excellent protection against having colds and sore throat at all.

When you realize that full strength Listerine kills even the virulent Bacillus Typhosus (typhoid) and Staphylococcus Aureus (pus) germs in numbers ranging to 200,000,000 in 15 seconds, you can understand why it is so effective against cold weather complaints which are caused by germs breeding in the mouth.

To escape a cold—
rinse the hands with it

Colds can often be prevented by the use of full strength Listerine on the hands before each meal. It destroys germs which may be present, so that when they enter the mouth on food they are powerless to cause harm.

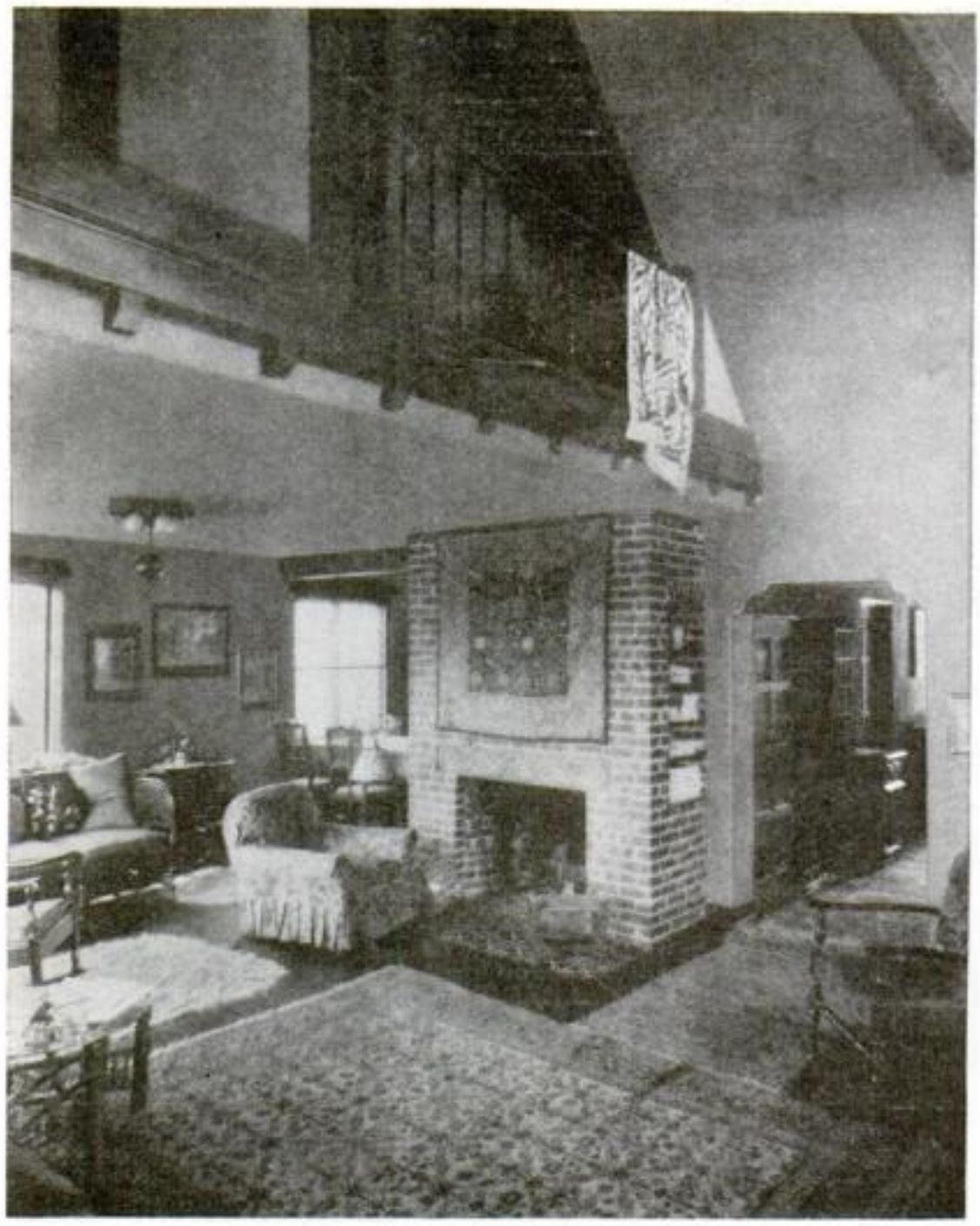
Though Listerine is powerful you may use it full strength, with entire safety, in any cavity of the body. Indeed, it is actually soothing and healing to tissue. This is commented on by the famous "Lancet," the leading medical publication of the world.

Keep a bottle of Listerine handy in home and office and use it frequently—especially after exposure to cold weather or germ-carrying crowds in offices, railway trains, street cars or buses. It may spare you a trying and costly siege of illness. Lambert Pharmacal Company, St. Louis. Missouri.

LISTERINE *THE SAFE ANTISEPTIC*

kills 200,000,000 *germs in* 15 *seconds*

Celotex Lath, used as a base for the handsome plastered surfaces of this room, protects their beauty from disfiguring plaster cracks and lath marks.



You protect the beauty of plastered walls *with* Celotex Lath

... and make sure of pleasant even temperatures in every room all year 'round

WISE home owners already know the urgent need for insulation in modern homes... understand how Celotex shuts out the cold and dampness of winter as well as the heat from summer sun.

Now home owners have learned about Celotex Lath... the plaster base that not only guards your home against all extremes of temperature but also provides lasting protection to the beauty of your walls and ceilings.

Celotex Lath comes in units measuring 18 inches by 4 feet. The size of the units and their overlapping joints prevent the streaky appearance and unsightly plaster cracks that so often occur with old-fashioned lath.

As insulation, Celotex Lath adds very little to your building costs ... it simply takes the place of ordinary lath. And in years to come it saves you hundreds of dollars in fuel bills by preventing costly leakage of furnace heat.

Your architect, dealer or builder will be glad to explain how Celotex Lath can be used in building your new home ... or in making the home you live in now more enjoyable the year 'round. Get in touch with him at your first opportunity.

And write for our interesting new booklet, "Celotex Cane Fibre Insulation," telling how Celotex provides greater comfort and lower fuel bills.

The Celotex Company, 919 North Michigan Avenue, Chicago, Illinois. In Canada: Alexander Murray & Co., Ltd., Montreal. *(Member of the Home Modernizing Bureau of the National Building Industries, Inc.)* Sales distributors throughout the world. Reliable dealers can supply you with Celotex Standard Building Board and Celotex Lath.

IDEAL FOR REPAIRING AND REMODELING

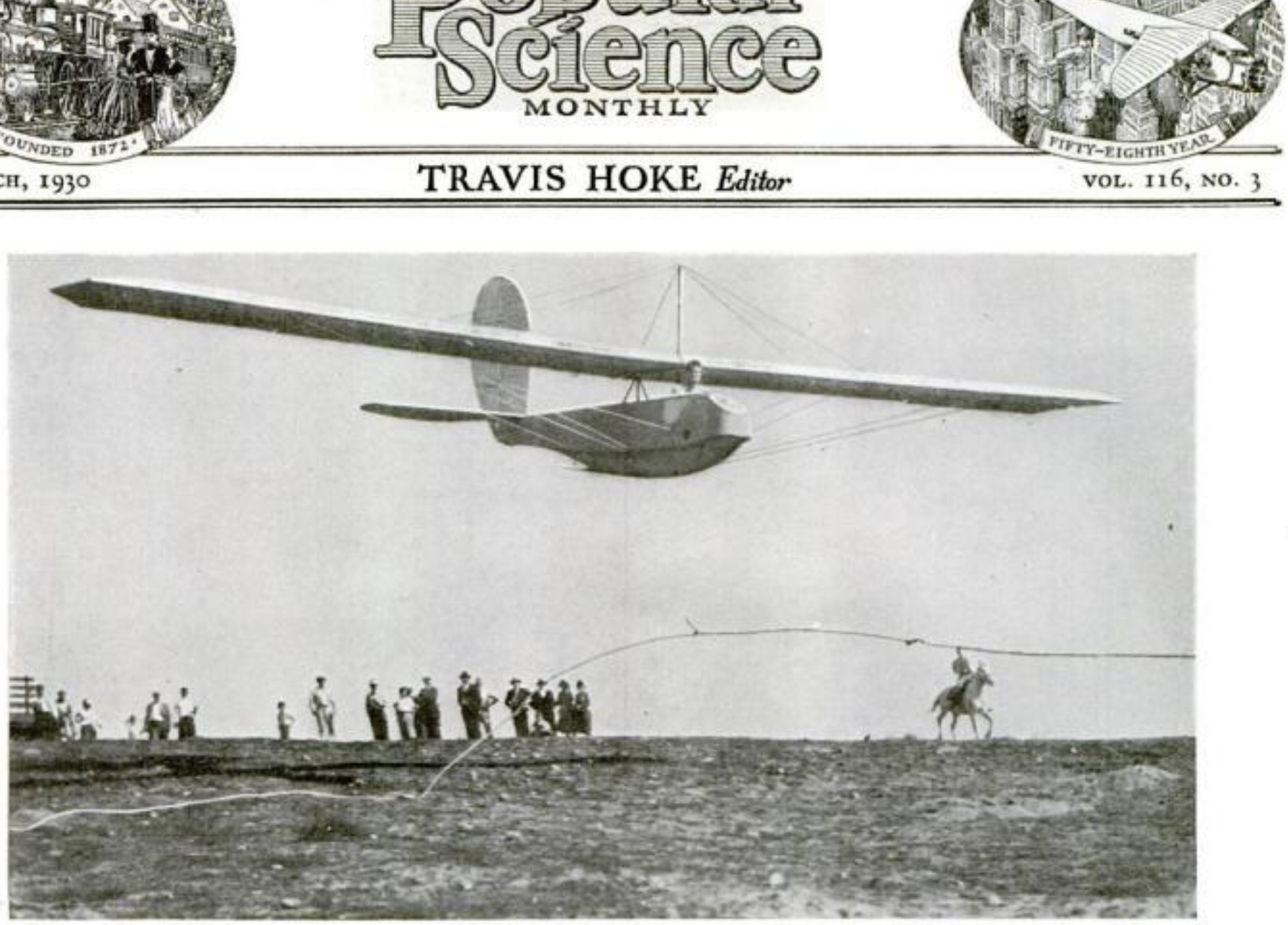
Attics lined with Celotex Lath transform wasted space into pleasant, livable rooms. The rigid units are light and easy to apply. Where attic space is limited, you can keep the whole house more comfortable by nailing Celotex Lath to the attic floor joists and stopping the costly leakage of furnace heat.

The word CELOTEX (Reg. U. S. Pat. Off.) is the trademark of and indicates manufacture by The Celotex Company Chicago, Illinois

CELOTEX BRAND INSULATING CANE BOARD LATH

Popular Science Monthly

March, 1930 TRAVIS HOKE *Editor* Vol. 116, No. 3



Snapped into the air by elastic cable—the launching of a glider at Los Angeles, Calif.

Thousands Are Flying Gliders

Within the year the sport of gliding has advanced to a point where it is safe, easy to learn, and useful. More than a thousand American men and women, girls and boys, now are following it with enthusiasm. Other thousands are preparing to try their wings. Here is the first of a series of articles explaining all the facts about this thrilling outdoor sport which is training the aviators of the future.

By

EDWIN W. TEALE

MORE than a thousand Americans are flying without motors. Thirty-two gliding clubs, scattered from coast to coast, are in operation and fifty more are being formed. In one state, Ohio, there are nine clubs, all affiliated with the National Glider Association. A dozen companies are turning out motorless craft for sale. The California factory where *The Spirit of St. Louis*, Lindbergh's famous plane, was built has just been taken over by a concern which plans to turn out soaring planes in mass production. In several parts of the country, schools are teaching the fine points of riding the air currents. Gliding—older than the airplane—has come into its own.

In Germany, for instance, where gliding had its start, 200,000 people, ranging from school children to middle-aged business men, have joined gliding clubs. In 1928, more than 10,000 flights were made from German hillsides and 3,000 schoolboys were instructed in handling gliders. At an international motorless plane meet in the Rhoen Mountains last year, 105 competitors spiraled and swooped like birds. In fact, so birdlike are these silent, wide-winged, soaring ships that when Peter Hesselbach, two years ago, circled over the headland and sea at Cape Cod, Mass., for more than four hours, a dozen gulls came in from the ocean and fell in behind, following the strange machine fearlessly for a quarter of an hour at a time.

The value of gliding as a training for powered flight is fully recognized. German transport lines require glider licenses of their pilots. In America, the Curtiss-Wright Flying Service, controlling forty fields and operating schools in all parts of the country, plans to build gliders and to instruct students in their use. Famous pilots, as well as beginners, are enthusiastic over the sport of motorless flight. Charles A. Lindbergh, Amelia Earhart, Frank M. Hawks, and "Eddie" Stinson are among the many noted flyers who have recently climbed into the air on motorless planes.

A beginner on a glider is not disturbed by the speed, roar, vibration, and fumes of a motor. There is no throttle to regulate. He can concentrate upon maintaining balance, getting "the feel of the air." This saves time later during powered instruction. Reduced tuition is offered by some German aviation schools to expert glider operators. Boys, too young to learn to fly, take up gliding as a link between models and powered planes. They get into the air cheaply and safely. Properly conducted, gliding entails a minimum of risk. There is no fuel tank and consequently no fire hazard in a rough landing. Instead of making contact with the ground at express-train speed, as in an airplane, a glider drifts to a landing against the wind at a few miles an hour. Early flights in primary gliders are made only ten or twelve feet from the ground.

Last summer, 800 flights were made at

Above: William Atwood riding his glider above a hillside at San Diego, Calif. He reached an altitude of 200 feet. Right: Baron Freyberg-Harth, German glider, flying a birdlike soaring plane in which he remained in the air more than two hours.

Cape Cod and not a student was hurt. In one week at the University of Michigan 125 people safely hopped off a long hillside, and seven of the pilots were girls. One German glider has carried 5,000 people aloft without an accident.

TO UNDERSTAND the fascination of literally riding on the wings of the wind, consider the thrills and the unexpected in a single soaring adventure of the German pilot, Wolfram Hirth. Lifted from a mountain side by an updraft, he soared into a low cloud bank. For minutes he flew, silent as a ghost, through enveloping mist. Then, losing altitude, he drifted down out of the clouds above a mountain meadow. Boys, herding cows, ran to see him land. But just as the tail skid was swishing through the long grass, an unexpected upcurrent poured through a small gap in the mountain, carried him a hundred feet in the air, and enabled him to glide over the hills to the valley beyond. For more than half an hour he soared about, taking advantage of every rising current, following a railroad that crept up the valley, winging his way over forests, villages, and rivers. At Steinach, the inhabitants rushed into the streets to stare up at the giant bird sailing overhead.

Swinging back and forth above the ruined Steinach Castle, Hirth then rode an updraft hundreds of feet into the air and sailed over the next range of hills to the broad Saale Valley. As he passed over the railway depot of the resort town of Kissingen, he played "air ghost." Leaning over the side of the cockpit, he shouted: "Hello there!" startling the people standing on the platform waiting for their train.

Beyond the town, two mountains came together at an acute angle. A north wind blowing into the corner made a trap for the soaring plane. It lost altitude. Again the tail skid almost touched the grass, when another unexpected gust carried the glider aloft and Hirth guided it above the mountain saddle. In the next valley the flight ended. As he was losing altitude, Hirth saw a motorist on a lonely road. He circled the machine and then drifted down to a landing in a meadow a few yards from the road. The autoist took him to town and he notified his friends of his whereabouts.

By similarly jockeying motorless ships to take advantage of rising air currents, an American pilot, W. H. Bowlus, a few weeks ago, soared over Point Loma, Calif., for an American duration record of five hours and twenty-seven minutes, and a German soaring ace, Hermann Dinort, swung back and forth above the sand dunes on the Baltic seacoast for fourteen hours and forty-four minutes, setting a world record. During this long motorless flight, Dinort weathered a fifty-mile gale and flew most of the time through darkness.

How is it possible for a machine weighing several hundred pounds to hang in the sky from morning until night without using a motor? Two factors enter into an explanation of this seeming miracle.

In the first place, soaring planes are perfectly streamlined. They are built of the lightest material, so that the loading per square foot of wing surface is low. Consequently, many soaring machines have a gliding range three times that of the ordinary airplane. They advance twenty feet for every one they descend. This enables them to travel long distances from moderate heights. The second factor in motorless flight is found in rising air currents. When a wind strikes the side of a range of hills, for example, it is deflected upward and forms a rising current. In such a column of rising air, the soaring plane gains altitude, being carried upward faster than it descends. The pilot guides it from one rising current to another, the height lost in gliding between air columns being regained in passing through them. For soaring, hills and preferably ridges facing prevailing winds are required.

HOW slight an upcurrent will sometimes keep a light soaring ship in the air was demonstrated recently in Ohio. The "Akron-Condor" soarer, with W. Klemperer, the famous sail plane pilot, formerly of Germany, at the controls, was being towed from Akron to Cleveland by one of the Goodyear blimps. Near Wallings Corner, the towrope parted while the glider was 700 feet up. In spite of its low altitude, it sailed for five miles and landed in a large field. The pilot had difficulty in landing because the heat currents rising from the ground caused the soarer to float nearly the entire length of the field at an altitude of only a few feet.

Between soaring and gliding there is a sharp line of distinction. In soaring, the machine rises on upward air currents higher than its starting point. In gliding, it descends from a higher to a lower place, "sliding downhill" on the air a few feet above the ground much as a sled coasts over the snow.

The first step in learning to soar is simple gliding. Primary training gliders, heavier and less efficiently streamlined than soaring ships, are used. A dozen men, running into the wind at the ends of a long rubber cable while others hold back the machine, launch the primary glider as well as the soarer. When the cable is stretched the men at the tail release the glider, which shoots into the air and sails to the bottom of the slope. During the glide, the machine is governed by a regulation stick and rudder bar control. Advanced pilots often go aloft towed by automobiles or airplanes, cutting loose when sufficient altitude has been gained.

A hop of thirty seconds straight down a hillside earns for the pilot a third-class glider pilot's license and the one-star insignia of the National Glider Association. A one-minute hop with a complete right, left, or "S" turn entitles the pilot to a second-class license and a

Next month: "How to Get into the Gliding Game." Another interesting article giving facts that everyone interested in this thrilling new sport will want to know.

double-star insignia. A soaring flight of five minutes above the starting point gives him a first-class license and the coveted three-star insignia. Three American pilots hold first-class licenses, W. H. Bowlus, W. Klemperer, and Lieut. R. S. Barnaby, U. S. N. The latter plans to conduct experiments in landing passengers from the dirigible *Los Angeles* at Lakehurst, N. J., by means of gliders.

THE cost of motorless planes ranges from about $435 for primary training gliders to several thousand dollars for delicate, record-breaking soaring ships. In this country the usual plan seems to be to organize a club and buy a primary machine, the members sharing the expense. One member is then chosen to go to a glider school for expert instruction and on his return he teaches the others. Thus, the individual cost is kept down, at the same time providing safe machines and competent instruction, without which gliding should not be attempted. Many students are able to fly gliders after one hour of instruction. A mobile gliding school is planned by the National Glider Association to make easier the training of "key men" in different sections of the country. This school would move its planes, hangars, and instructors about from place to place, giving instruction. The use of the old-fashioned, dangerous "hang" glider, in which the operator dangles from arm rests and preserves balance by swinging his legs from side to side, is not recommended by the Association.

At the moment of launching. The men in the foreground have run down hill, pulling the motorless plane by a cable, into the wind.

These girls are receiving instructions in piloting motorless planes at the first women's glider school established near Berlin, Germany.

It was upon such machines that the pioneers of thirty and more years ago made their first flights. For gliding is more than a sport. It gave the world the airplane. In the latter part of the nineteenth century four men—a retired German manufacturer, Otto Lilienthal; an English sailor, Percy Pilcher; a California college professor, John J. Montgomery; and a French-American bridge builder, Octave Chanute—blazed the trail with motorless machines to the conquest of the air by the Wright brothers.

When the airplane appeared, gliding languished. All attention was directed to powered flight. In 1911, Orville Wright took an English friend to the Kitty Hawk dunes and made some gliding flights for fun. On one he hovered for nine minutes and forty-nine seconds in a gale. So slight was the activity then in gliding that for ten years that record stood unchallenged. Following the war, the restrictions put upon German aircraft by the Versailles Treaty turned attention in that country toward motorless machines. In the Rhoen Mountains of central Germany and among the dunes of the Baltic coast, the soaring ships hung in the air for longer and longer periods. The records culminated in Dinort's recent flight of nearly fifteen hours.

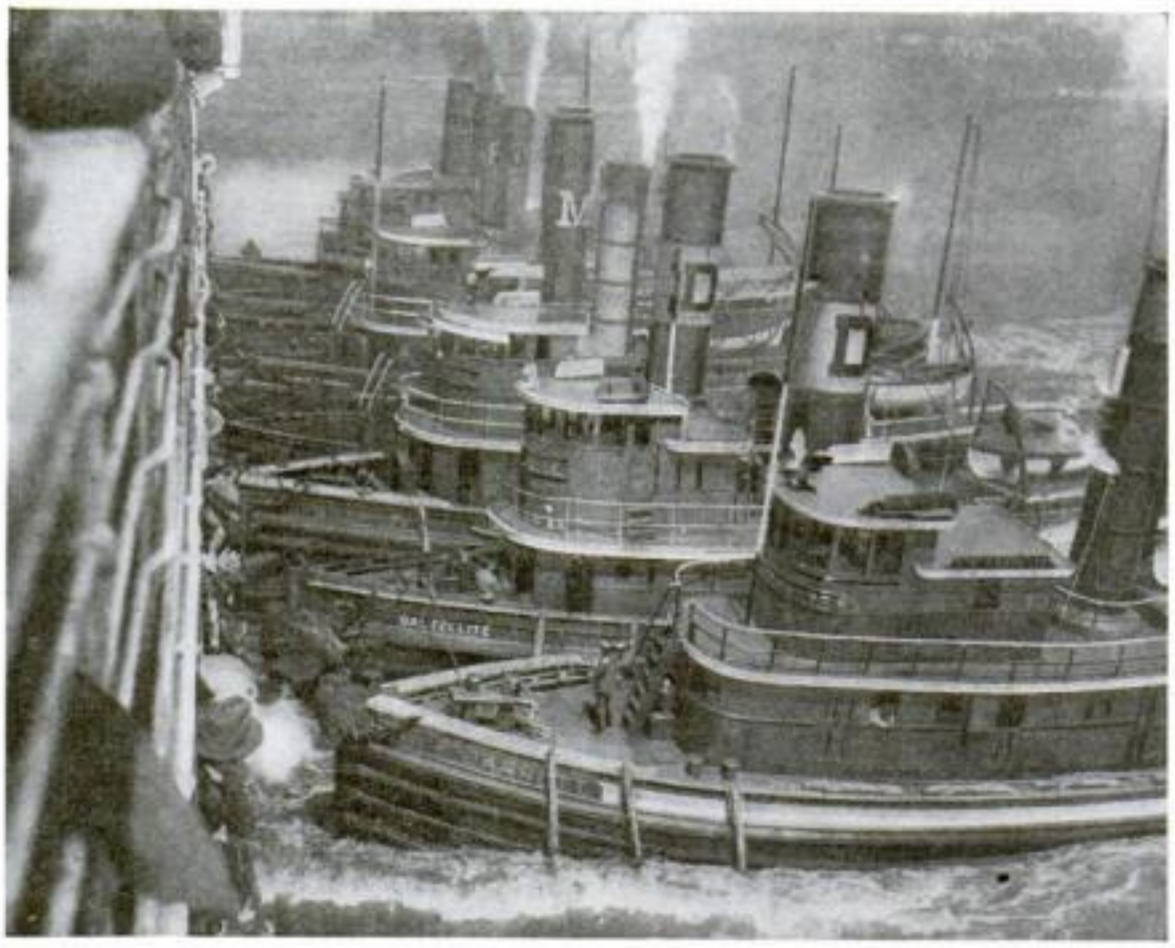
In America, gliding has taken a new hold in the last two years. The soaring flights at Cape Cod, in the Alleghenies, and on the Pacific Coast have attracted fresh attention to the sport which Montgomery, Chanute, and the Wrights employed to learn the secret of flight three decades ago. Last year, motorless flying meets were held at Detroit, Mich.; Cleveland and Lima, Ohio; and Los Angeles, Calif. The first International glider air mail was delivered recently when Oscar Kuhn, a pilot for Gliders, Inc., of Detroit, made a towed flight over the border to Windsor, Canada, and soared down to the airport to deliver a packet of letters.

One horsepower hauls the glider plane to the top of a hill for the take-off. It's a long way up, but great sport to ride the air coming down. A scene during a recent motorless plane contest.

THE only official American glider record, at this writing, is the five-hour-and-twenty-seven-minute duration flight of W. H. Bowlus. To be official, a record must be observed by three timers or judges authorized by the National Glider Association. The present unofficial records are: distance fifteen and three quarter miles, set in the Alleghenies in 1929 by W. Klemperer; altitude, 600 feet, also set by W. Klemperer in 1929.

Seven kinds of glider records are recognized by the Association. They are duration, with return to point of departure; duration, without return to point of departure; distance, air line; distance, with return to point of departure; altitude above start- (*Continued on page 154*)

How Pygmy Tugboats Dock a Giant Liner



"Swinging the huge liner broadside to the current is like forcing a dam forty feet deep and 900 feet long upstream. Against a mountain of water the tugs pit their strength."

By ROBERT E. MARTIN

A SHEER eighty-foot cliff of steel rising straight into the air. Small white faces peering down from the rim. A pygmy figure, wearing an aviator's helmet as protection from the biting wind, standing on the bridge a hundred feet above the water. Handkerchiefs, hats, an orange flag, waving frantic greetings from a dozen round portholes piercing the metal wall. That was the tug's-eye view of the *Leviathan*—America's greatest liner—which I obtained the other day when I rode up the North River from New York Bay to see first-hand how a liner is docked.

Captain Allan Howell, of the tug *Dalzellea*, had picked me up at the Battery landing where the busy Statue of Liberty boat takes visitors from all over the world to see the famous Bronze Lady. Howell is square shouldered, firm jawed, has a humorous twinkle in his eye. Since 1903 he has been meeting the big ships that come in from the sea—"putting the liners to bed."

While the *Dalzellea* plowed up the North River—as all seamen call the mouth of the Hudson—past steamers, ferries, and barges, he explained some of the difficulties in docking a liner. Big ships can neither start, stop, nor turn quickly enough to enter a slip without the aid of tugs.

As everyone knows, the *Leviathan* is between 900 and 1,000 feet long. Coming into port, it weighs more than 60,000 tons. Yet the problem of swinging the liner around and moving it into its slip would be simple were it not for the complicating factors of wind, tide, and ice.

One night, a few years ago, a wind swung the *Leviathan* around just as it approached its slip and jammed the vessel across the ends of the two piers, bottling up the slip. Three tugs were caught inside, the rest outside. Those inside pushed; those outside pulled. The big ship wouldn't budge. Additional tugs were called. The vessel remained glued in place by the force of the gale. The battle lasted almost all night before the liner was safe in its berth. Anyone who has struggled against a wind with an umbrella will appreciate the force necessary to push back an ocean liner whose side is like a gigantic billboard nearly a thousand feet long and eighty feet high. Once, when the same vessel was being dry-docked in Boston, in spite of the combined efforts of sixteen tugs, a wind swung it out of control, smashing a pier.

BUT wind is only one of the enemies of a successful docking, Captain Howell told me. The direction and strength of the tide, the amount of floating ice in the water, the presence of other vessels in the slip—all these influence the maneuvers necessary to bring a liner to its berth. No two dockings are the same. Every one is a battle of wits against a new combination of conditions.

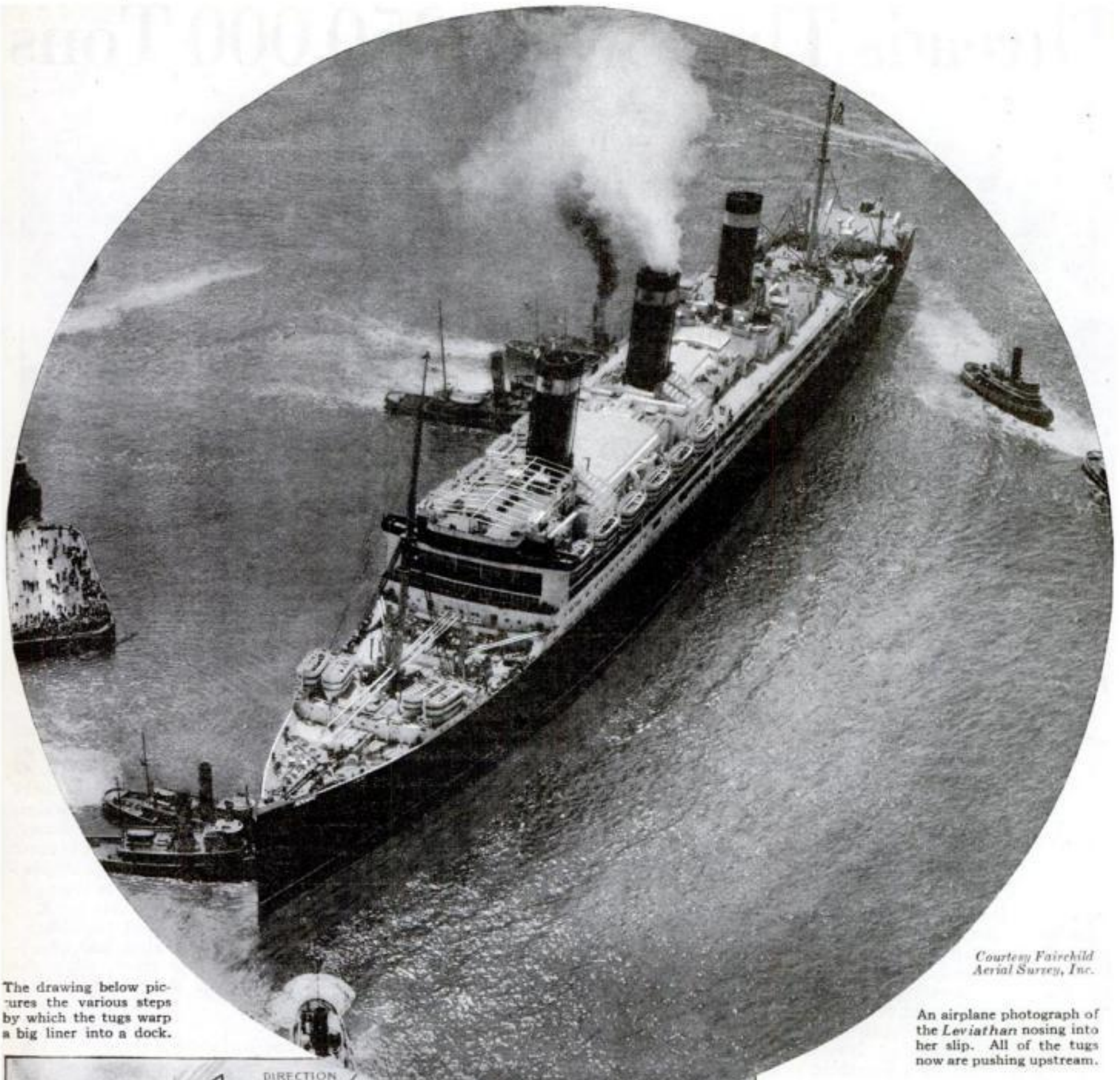
At Pier 86, on the Manhattan side, we made fast, waiting for the liner to come up the river under its own power. At Pier 85, in the slip between 85 and 86, lay the *Deutschland*, the Hamburg-American Line's huge "bubble ship"—so-called from the bulging lines of its "antiroll" construction. Between the *Deutschland* and Pier 86 was a strip of water a little more than 200 feet wide. Into this strip the *Leviathan*, with its 100-foot beam, had to enter like a thread approaching a needle's eye. If it drifted south, it would crash into the *Deutschland*. If it swung north, it would smash the pier.

ALONG Pier 86 were five "camels"—huge floating fenders placed at regular intervals. These heavy-beamed rectangles keep the ship from coming in contact with the pier, while allowing gangplanks to reach across. A few years ago, a liner tore away part of its pier when smaller "camels" were substituted without warning to the harbor pilot who docked the ship.

Two long blasts of a whistle. Two short blasts. The *Leviathan* was coming. Heading upstream, into the ebb tide, the sea giant came to rest opposite the pier. Eight tugs swarmed around it, falling into predetermined positions. The *Dalzellea*, with three others, nosed against the hull near the stern on the pier side. It was like stopping below a huge warehouse seven stories high and three city blocks long.

"That's Billy McLaughlin, the harbor pilot," said Captain Howell, pointing at the man with the aviator's helmet on the bridge far above the water. "The Captain of the ship is always in command, but McLaughlin, as 'local guide,'

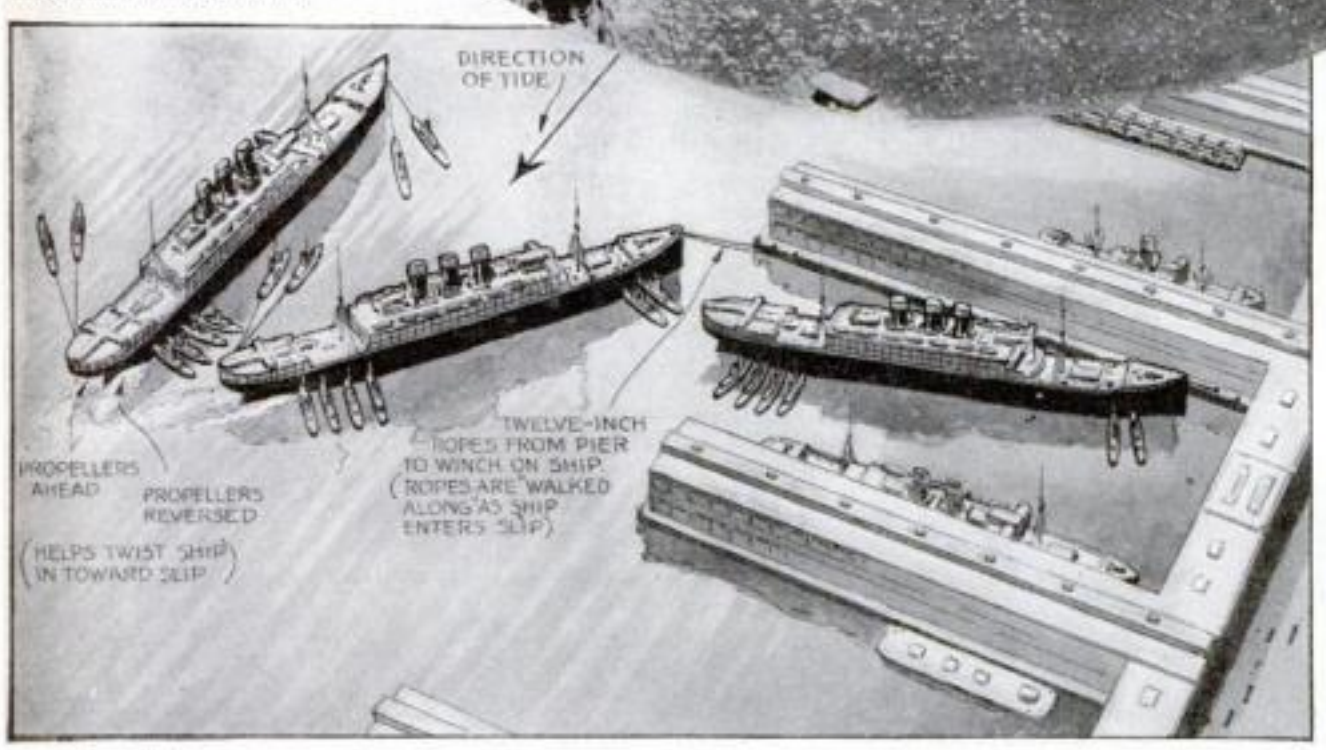
As the *Leviathan* turns broadside to the stream, two forward tugs cease straining at the hawsers to push at the bow.



Courtesy Fairchild Aerial Survey, Inc.

An airplane photograph of the *Leviathan* nosing into her slip. All of the tugs now are pushing upstream.

The drawing below pictures the various steps by which the tugs warp a big liner into a dock.



directs the tugs. He blows a police whistle to signal them." During the war Captain Howell himself docked the *Leviathan* many times. Once it was so cold the metal of his police whistle stuck to his lip, taking off the skin. Afterwards, he used one with a celluloid mouthpiece.

For several minutes we waited. "It is nearly slack water," Howell told me. For six hours the tide comes in, then for six hours it runs out. Just before the change, there is a period of slack water. This is the easiest time to dock a ship. Government bulletins tell pilots the exact minute to expect high and low tide and slack water. In New York Harbor, the direction of the wind is an important factor in determining the height of the tide. An east wind means a high tide—a strong west wind, a much lower one. Scientists of the Hydrographic Office are helping with more and exact information. One large fleet of tugboats is soon to be equipped with radio to receive the latest information and instructions.

One shrill whistle from the bridge. We look up. McLaughlin has one arm lifted in the air. Begin pushing. The engines of the *Dalzellea* commence throbbing. Two whistles. The figure on the bridge holds up both arms. Full power ahead. The water boils behind the tugs. White lines of beaten foam stream a w a y (*Continued on page 152*)

Threads That Swing 350,000 Tons

How the Strongest Cables in the World Support the Load of Huge Bridges, Carry Aerial Railway Cars, and Serve the Many Needs of Engineers

By

FREDERICK TISDALE

How great logs are hauled from the north woods by trolleys running on steel cableways.

Responding to a hurry call, a welder and his truck speed by cableway across the Mississippi.

"THE wire's got to come down—every strand of it." The speaker was one of a group of engineers for the new Ambassador Bridge, that was to link Detroit to the border cities of Ontario, Canada. They stood at an anchorage, examining one of the huge cables that supported the 1,850-foot main span, longest in the world.

Minute cracks in the silver-bright wire added their testimony to chemical and breaking tests. There was no argument. The wire came down, though two and a half million dollars in labor and materials were lost. Sputtering acetylene torches ate away the condemned filaments in great chunks. Every thread was replaced with cold drawn filament of which there was no doubt, and the improved bridge was opened to traffic last November. Engineers who had tried something new on that bridge—a wire heated after it was drawn—had learned a lesson, and so had the scientific world that had watched the crucial experiment in cable-making.

Ever since some unnamed German genius, 600 years ago, discovered that cold metal drawn through a hole in a die would make a wire, the art of cable-making has steadily improved. Because of one such advance the forty-seven-year-old Brooklyn Bridge, in New York, today is safely carrying twice the load for which it was originally designed. The first specifications called for cables of iron wire to support the bridge. Before the spinning of the cables began, steel wire was perfected. Engineers seized the opportunity to improve the bridge, and in went steel wire. Similarly the new bridge across the Hudson River from New York to New Jersey, which will be the greatest suspension bridge in the world, is to be stronger than its specifications require. Ways have been discovered to make its cables stronger even since the work began.

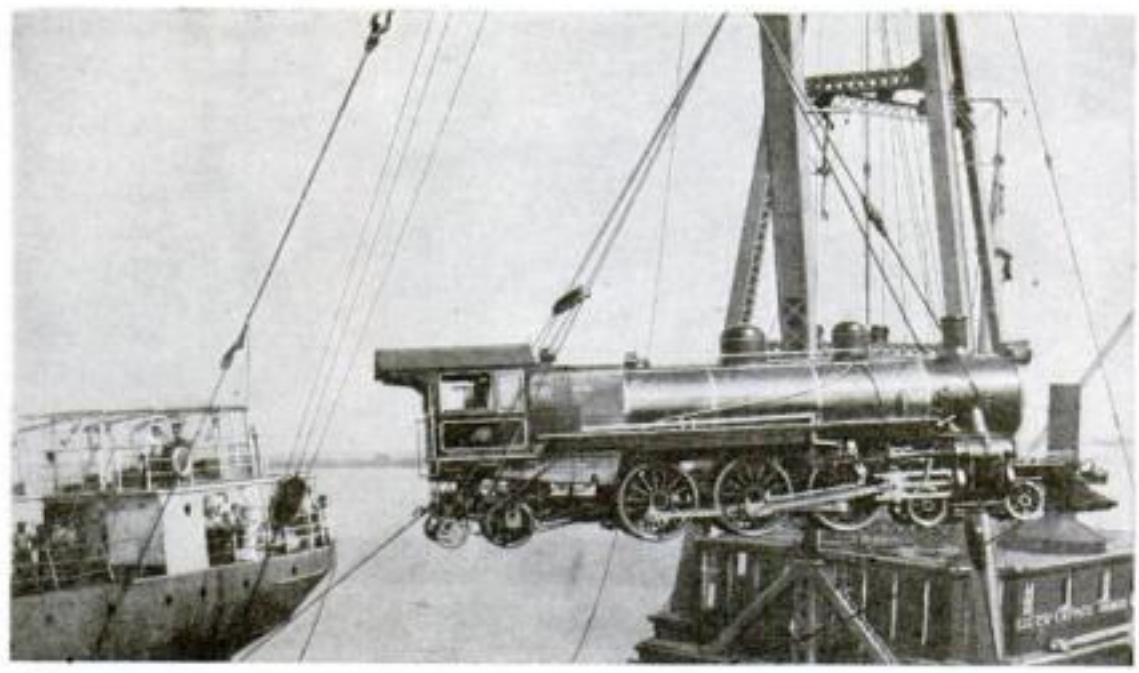
Not in bridge cables alone does wire rope demonstrate its strength. A locomotive made in Philadelphia must be delivered to a railroad running through the Andes. At tidewater a wire rope sling embraces the engine, while another lifts it and lowers it gently into the hold of the steamer. Similar slings and steel ropes hoist skyward the beams for tall buildings.

In mines, workmen and materials descend to the depths on cables of wire, and other cables handle the heavy drills that bore for oil. Modern logging uses the strands to snake the huge trunks through the woods to the rail line. Blocks of granite rise out of quarry pits on wire slings hung from wire rope. Wire makes possible the handling of huge bulks at sea; the drydock *Dewey* was towed from Chesapeake Bay to the Philippines, 13,000 miles, by a pair of steel hawsers.

One of the most spectacular applications of the strength of steel rope is in aerial railways that carry passengers and materials in cars slung from ropes high above the ground, to aid in building dams and crossing ravines. When a set of locks was being built not long ago at Lockport, Ill., a welder was needed in a hurry. Answering a telephone call from the other side of the Mississippi River, he decided not to take the time to drive to the nearest bridge. He hooked his auto truck to the cableway that spanned the stream, was hoisted many feet aloft, and, standing atop the swaying truck, made the journey safely on the slender metal strands.

THE length of some of these aerial railways is surprising. A sky tramway twenty-one miles long runs from the mines of the Mejicana district, in Argentina, down to the town of Chilecito, carrying coal. On the return trip the cars transport supplies, and other special cars carry inspectors and mail. To reach the two-mile elevation of the upper station the tramway at times exceeds a grade of one to one, and at one point it passes through a mountain tunnel. Colombia has a large tramway of even greater length.

In the United States aerial tramways play an important part in the transportation scheme. Where railroads cannot run and boats dare not navigate, the cable cars glide



Slings of steel rope lift a railway locomotive bodily from a lighter and transfer it safely into the hold of an outgoing steamship. Similar slings hoist the steel beams for skyscrapers.

smoothly along at four to six miles an hour. The monorail cars—for they generally hang on flanged wheels from a single wire—cross mountain gorges and treacherous rivers, carrying lumber, coal, ore, and other products. One cableway, four miles long, carries apples from the largest irrigated orchard in the country to the nearest railroad, near Weiser, Idaho. Barges with loads of pulpwood for a Hopewell, Va., paper mill anchor at a wharf in the middle of the shallow James River rather than risk going inshore—and an aerial tramway whisks the load ashore. And these are only two uses out of hundreds.

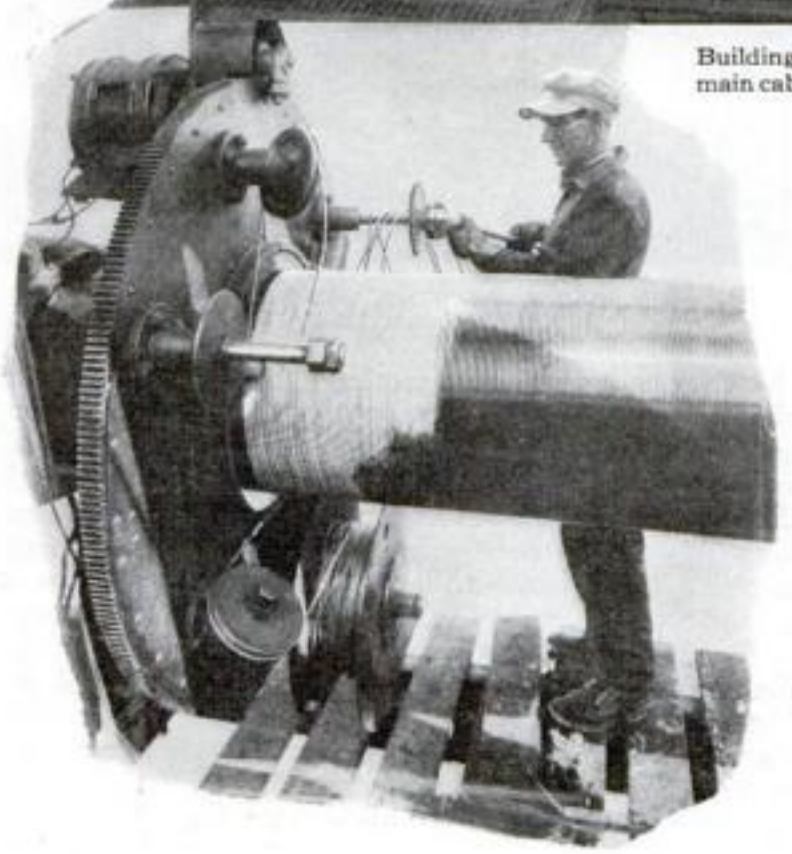
THE making of wire for cables has become a fine art. By successive drawings steel has been reduced to wire so fine that it can hardly be seen without a magnifying glass. In the final stages the filament is drawn through holes bored in diamonds, the only substance hard enough to resist cutting by the metal. Wires one four-thousandth of an inch in diameter, one twelfth as thick as a human hair, have been drawn. Such threads burn like wool over a match. Most of this fine drawing is done as a stunt, though extremely fine wires are used in marking lines of delicate magnifying instruments, or in making springs for small watches.

At the other end of the scale are the monster wire ropes. One of the largest, a cable three inches thick manufactured for an iron mine in Cuba, was so stiff that it could not be delivered on reels. It was coiled about the deck of the freighter that carried it to its destination. Hitched to powerful machinery, it draws half a million pounds of ore in one haul.

To the maker of steel rope a wire hawser is a piece of machinery. All rope is oiled when it comes from the factory. The core is the heart of the rope and if flexibility is desired it is made of oiled hemp. For stationary ropes such as guy wires a steel core gives greater strength and rigidity.

A common form of rope-making machine is an upright steel cylinder with arms branching from its base. At the end of these are bobbins carrying the strands to make up the rope. They feed into the center of the column which carries the core. The turning of the steel column twists together the strands.

Building the cables for the new Hudson River Bridge. Each main cable—a bundle of straight wire—will be three feet thick.



A machine wraps a binding of soft galvanized iron wire around one of the cables of the new Ambassador Bridge across the Detroit River. This nineteen-inch cable contains 8,066 steel wires.

When enormous cables for bridges are made, an entirely different procedure is followed. Twisted rope cannot be used here. Strands laid parallel to each other and "spun" together by encircling wires are employed instead. The reason is that a rope made of strands containing fifty wires is only about eighty-five percent as strong as fifty wires laid parallel. When wire is crossed in twisting, the separate filaments rub against each other and thus lower the breaking point of the cable.

One of the best examples of modern cable making was the construction of the cables that will support the new Hudson River Bridge. These cables must be capable of sustaining a dead weight of 350,000 tons, about the weight of six ships of the *Leviathan's* size. To do this the four main cables—bundles of straight wire three sixteenths of an inch in diameter—are three feet thick each.

Bridge wire used for the Hudson span comes from ingots of steel fourteen inches square and five feet long. After careful chemical analysis, selected ingots are reheated and rollers reduce them to sections two inches square. Clipped into thirty-foot billets, these in turn are worked smaller. Leaving the rolls, the steel is a round rod similar to a curtain rod, and three eighths of an inch in diameter. That is as far as the rolls can go toward turning steel into wire.

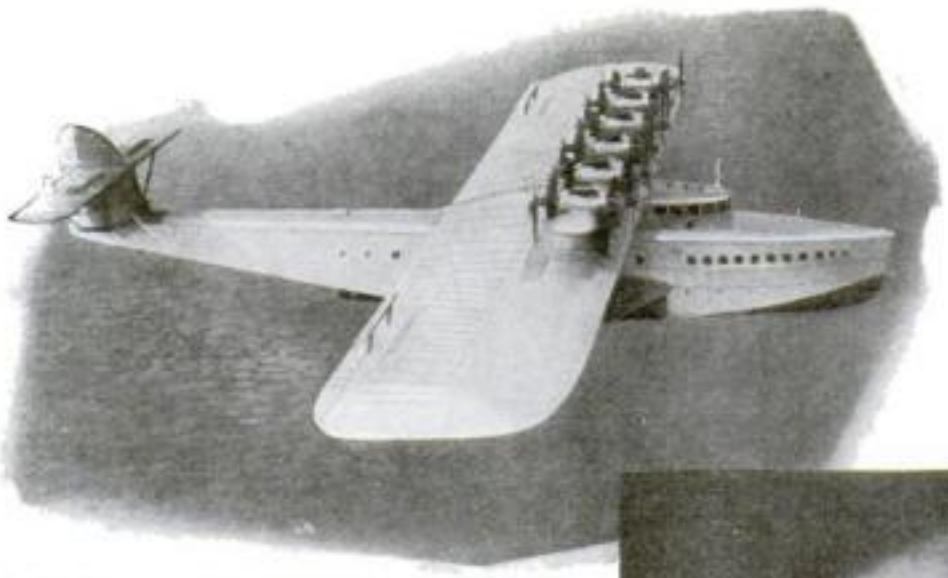
NEXT comes the die through which the wire is cold-drawn. But the rods are not squeezed through it. Instead, they are tempered, cleaned, and pointed so that an end can be thrust through a hole in the die. A "dog," a powerful mechanical hand, seizes the small tip and pulls through enough wire to be fastened about a drum. The drum then exerts enough pull to drag the steel through the hole. Passing through four holes each a little smaller than the last, the rod is reduced to wire of the required size. Four thousand feet of wire are drawn from each billet.

This drawing of wire through a hole too small for it does not weaken the wire, as might be imagined, but actually strengthens it. The fibers of metal are drawn into a parallel position which resists any break. Mighty testing machines in the wire factory check up on that. A loud report like that of a cannon means that a wire has finally broken in the testing machine, which can exert forces of as much as two million pounds. One of the single strands of wire used in the Hudson cables would require the combined pull of ten strong horses to break it.

The greatest spinning job the world has ever seen, the (Continued on page 164)

A New Figure in American Flying

By ALDEN P. ARMAGNAC



Dornier's mammoth *DO-X* flying boat carrying 169 persons over Lake Constance.

A SHORT, shy man stepped from a gangplank the other day on his second visit to America—Dr. Claude Dornier, premier German aircraft builder. He explained his mission simply. "The aviation of the future is in big flying boats. I think America is the logical place for their development."

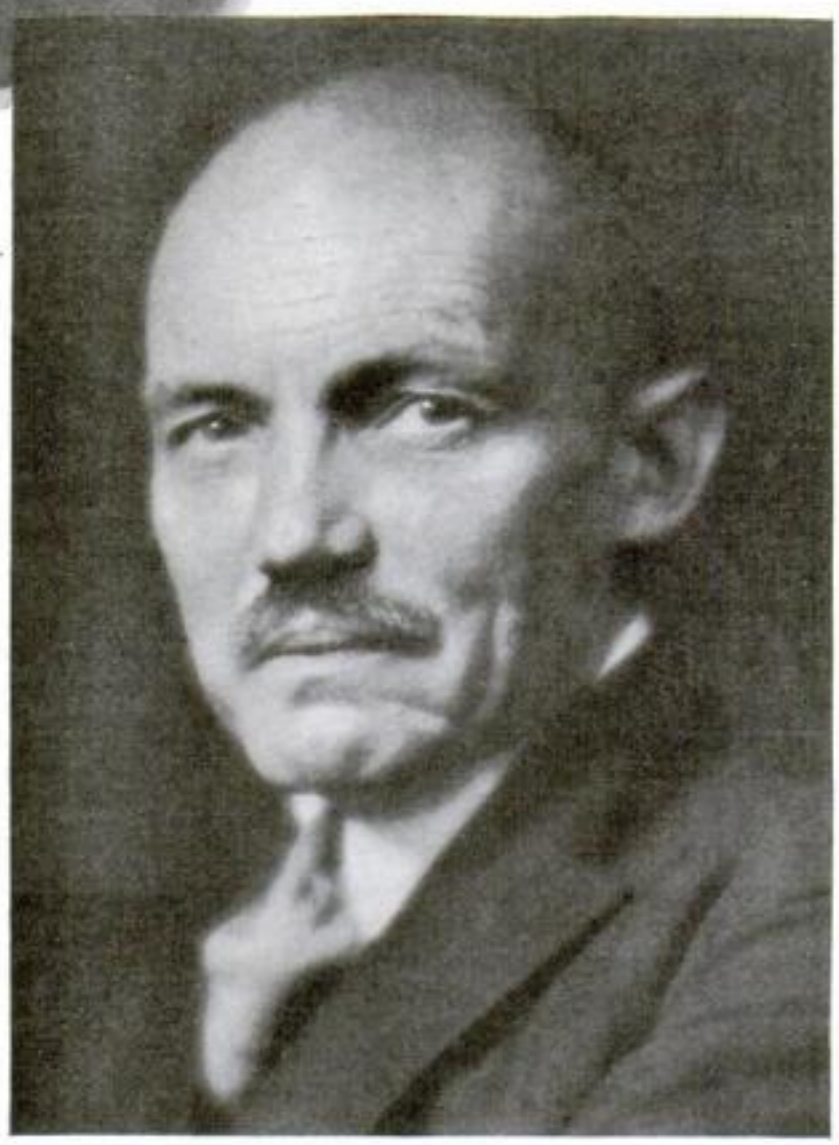
On his first visit, in January, 1929, Dornier spoke guardedly of a mammoth seaplane under construction at Lake Constance in Switzerland, a ship so enormous that probably no one save himself quite believed in it. By the time of his second arrival in this country his great air boat, the *DO-X*, had astounded the world by carrying 169 persons into the air. A striking painting of that great craft is shown on our cover this month.

The success of the *DO-X* gives new importance to what Dornier has to say about big seaplanes for America. A ship like the *DO-X* can be used, he says, for an eleven-hour air line between New York City and Miami, Fla. It could link the cities of the Great Lakes region, and take advantage of America's unique system of inland waterways. Passenger fares for such an air liner need be only half again as much as railroad fares, for travel two or three times as fast.

Evidently Dr. Dornier's statements have impressed American business leaders. A firm to build all sizes of his airplanes in this country—first the smaller ones, then liners of the *DO-X* type—has been formed by the General Motors Corporation and the Fokker Aircraft Corporation. It has bought his licenses outright.

Here is a new figure in American aeronautics. Though he is reticent in talking about himself, a few minutes' conversation reveals that he is not only an airplane designer but also an airship expert and a metallurgist of unusual ability. It was this broad experience that enabled him to crown his career by building an airplane many engineers had branded impossible.

WHEN the late Count Zeppelin was building dirigibles, in 1914, one of his right-hand men suggested to him that dirigibles might not always have a monopoly of large-scale passenger carrying. The man was Claude Dornier. Dornier pointed out the advantages of huge flying boats. Count Zeppelin told him he would think it over. Shortly after, the Count founded a company to make metal flying boats and put Dornier at the head of it. The factory was at Friedrichshafen. Here



Dr. Claude Dornier, famous German aircraft builder, who now is planning giant flying boats for American transportation.

Dornier's metallurgical experience served him well. One of his first problems was how to make hulls and seaplane floats of light duralumin alloy that would resist the corrosive action of salt sea water. He found a way to treat the metal, first with electricity and then with lacquer, to make it impregnable.

The first of the five types of seaplanes that Dornier built was a little fifty-five-horsepower sport flying boat named the *Dornier-Libelle*. He has preserved a movie of one of this midget's first flights. It shows a tiny plane scudding from its lakeside hangar, wings folded back. Then the pilot touches a lever, and without stopping the plane unfurls its wings and takes to the air.

Bigger planes followed—the *DO-E*, a scouting monoplane of the metal flying boat type; the Wal—meaning "whale"—which was a 600-horsepower flying boat, and the Super-Wal, a thirty-passenger machine.

America had its first real glimpse of the Dornier ships only last summer, when the first of a fleet of four Super-Wals for a Great Lakes air line, brought here from Germany, was assembled and flown near Philadelphia. But these planes had been doing regular transport service in nearly every other civilized country of the globe. They had carried more than one aerial adventurer safely across the South Atlantic. And Dornier planes held more than forty world records for speed, altitude, and distance with varying loads.

All the time Dr. Dornier was evolving plans for a super-liner that could lift more than a hundred passengers. Many engineers called it impossible. He built a plant on the Swiss side of Lake Constance, at Altenrhein. By the end of 1927 he was ready to start work on his dream-ship.

It was a new experiment in aircraft building. "As flying boats increase in size," Dr. Dornier explains, "they must be modeled on accepted rules of naval design. It is just like building a steel steamship." Indeed, the ribs, braces, and watertight bulkhead partitions in the *DO-X*, as they took shape, resembled those of a seagoing vessel more than an airplane.

Just about two years after work started, the *DO-X* roared across the surface of Lake Constance under her own power. Thousands of spectators lined the banks. Among them were aeronautical engineers from France, England, and Italy. And the rumor spread that Dr. Dornier's great plane was a failure—it couldn't rise from the water.

For three hours the mammoth plane taxied over the lake. Actually the chief pilot, Richard Wagner, was taking no chances. He throttled the engines down, then opened them to nearly full power. He tested every control before risking the lives of the twenty engineers aboard and the structure of the ship which had cost $800,000 to build. At last Wagner moved the controls to lift position and opened the twelve engines to full power. As easily as if she were a bundle of thistledown, the fifty-ton plane glided into the air.

OF THE 125 seaplanes that Dr. Dornier has built, the *DO-X* is his chief pride. But while his factory is turning out three more of them—two for Italy and one for Spain—he talks of bigger ships to come. The *DO-X* is an "experimental type." There is no apparent limit, he says, to the possible size of an airplane.

Starting the process of hypnosis **by the method of** fixed gazing. **The subject, seated in** a comfortable **chair, looks** fixedly at a **pencil in the hypnotizer's** hand.

Many persons are inclined to look askance at hypnotism as something shady, bordering on quackery and the occult. But the ability to induce trancelike conditions of the mind has been demonstrated beyond doubt. In skilled hands, the practice is not only useful but scientifically reputable. In this article a Professor of Psychology in Syracuse University tells—

The Truth about Hypnotism

By WESLEY R. WELLS

MOST of the superstitions of the past still survive in some degree. Especially is this true in the field of psychology, one of the youngest of the experimental sciences. The majority of people probably believe in telepathy or "mind-reading," and yet this belief is lacking in experimental proof. Spiritism, the belief in the possibility of communication with spirits of the dead, is also lacking in scientific verification.

Hypnotism, though often associated in the popular mind with telepathy, spiritism, and occultism in general, is a different matter entirely. It has been accepted by the scientific world for almost half a century as a natural process explainable in terms of ordinary psychology without any mystery or "hocus-pocus" inherent in it.

The antecedents of scientific hypnotism are, to be sure, shrouded in superstition. Mesmerism, for example, never gained acceptance within the bounds of modern science because of its implication of "animal magnetism" by which the mesmerizer was supposed to accomplish his results. Mesmer, who mystified with the practice a century and a half ago, had originally been a student of astrology, and he took over the astrological notion of the influence on human fate of mysterious planetary and stellar forces into his theory of the influence of certain persons over others.

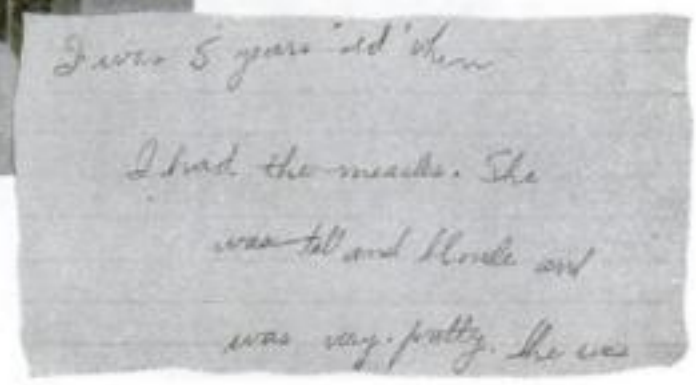
Though hypnotism involves nothing of "animal magnetism," telepathy, domination of weak wills by strong wills, or supernormal influences of any sort, the hypnotic phenomena themselves are sometimes so extraordinary that persons witnessing them for the first time often find it hard to believe what they see. Surprising conditions and processes may be induced in normal people. The bodily movements of the hypnotized subject may be controlled, arms or legs may be paralyzed, and the whole body rendered cataleptic. Other possible effects are illusions and hallucinations, blindness, deafness, complete anesthesia, loss of memory (amnesia), and increased memory (hypermnesia) for long past events.

Two years ago I had an interesting illustration of the use of hypnosis in recovering memory for forgotten childhood experiences. A young man reported to me that he recently had learned that his supposed parents were only foster parents, his own father and mother having died when he was a small child. He wished to have hypnosis used to aid him in recalling his own parents. Under hypnosis he recalled that, after his father's death, his mother was forced by poverty to move to a slum section of the city. His foster parents had concealed this from him, but later admitted the truth of it. He even remembered under hypnosis the funeral of his mother, which occurred when he was two and one half years old.

STILL other possibilities are alterations of personality and artificial, temporary cases of double personality, each personality being unaware of the other. In addition, so-called posthypnotic suggestions may be carried out. These consist of commands given during the hypnotic state to be carried out afterwards, sometimes weeks or months later. They are typically carried out without any memory by the subject of the original command in the hypnotic state. The suggestions may be in the nature of actions to be performed, of hallucinations to be experienced, or of anesthesia, of loss of memory, and, in fact, practically any of the phenomena capable of being produced in the hypnotic state itself. The subject may be made to go into the hypnotic state at a later time immediately upon the presentation of some agreed-upon signal, such as the clapping of the hands or the flashing of a light. Or the subject can be rendered unsusceptible to hypnosis in the future.

Within limits, there may be

"THE ability to hypnotize demands no unusual powers," says Professor Wells. "Nearly anyone who has watched the process can get some results in hypnotizing others. There is no justification, however, for the use of hypnotism for entertainment. Unskilled amateurs might do all sorts of injury to their subjects."



One of Professor Wells' students performing automatic writing with his arm in a sling to facilitate movements. The writing at the right was done by a healthy football player without being aware that his hand was moving. It is part of a description of a forgotten childhood incident.

produced changes of physiological processes not subject to ordinary voluntary control, such as alterations in the pulse rate, variation of the body temperature, changes in some of the glandular secretions, alterations of the functioning of the digestive system, and perhaps the production of tissue changes similar to blisters without the application of heat. This last group of processes, though reported by some of the workers in the 1880's and 1890's, and though verified to some extent in recent experimental work, is still open to some question among scientific investigators.

IN THAT connection, hypnosis has a very practical use, however, in showing the reality of so-called functional illnesses involving severe pain. When a person suffers, for example, from a persistent headache for which medical diagnosis reveals no organic basis and which does not yield to ordinary medical treatment, and when the physician finally labels the headache a hysterical symptom, friends sometimes think that the headache is "imaginary," and that the person is not really ill. The truth is that the headache in such a case is just as real and painful as if it were caused by a brain tumor. A surprising illustration occurred several years ago when I attempted a repetition of the so-called blister experiment.

A newspaper item had reported the case of a woman who had encountered a rattlesnake, who thought she had been bitten, and who soon began to suffer pain with marked swelling in one ankle, even though the snake had not actually struck her. Question arose as to the possibility of this, and one of my students proposed that an experiment be tried, of a somewhat analogous nature. I put the student into the hypnotic state, laid a half-dollar on one forearm, said it was a hot iron (the subject writhed with pain), said the iron was getting a little cooler so that he could endure it (the writhing subsided), and said that the heat would remain constant for twenty-four hours, during which time a swelling of the arm and a tissue change resembling a blister would appear. The subject was aroused from hypnosis and instructed to keep notes on results, and to report to me if at any time the pain became too great to bear.

Unintentionally I had overlooked one point, which was this: If a hot iron at *constant heat* were actually applied to one's arm, the *pain* would not remain constant, but would *increase*. I had said that the heat would remain constant. It did so (in the subject's experience), and the pain increased. Results are indicated by quotations of parts of the notes which the subject kept. The experiment had started at two o'clock. At 2:26 o'clock he wrote: "In bed with pain. Pain severe. Hot. Writhing. Consciousness almost blank. Can do nothing but try to relieve pain. Hot, sizzling. Cannot bear touching." At 2:40 o'clock he wrote: "Am crying with pain. Can write no more."

The subject then sent for me. When I arrived, I found him almost in a state of collapse. I immediately terminated the experiment, of course. I did not produce any tissue changes resembling a blister, but I did produce a very convincing demonstration of the reality of experienced pain without ordinary organic basis. Should not this teach us patience and sympathy with those suffering from hysterical disorders? Such persons are really ill; they really suffer; and they need the appropriate kind of treatment.

Various methods are employed to produce hypnosis. Simply talking to the subject is the most important. One psychologist recently had recorded on a phonograph record (to be distributed only to psychologists and to physicians) a series of sentences spoken in a monotonous and commanding tone to bring about the hypnotic condition in those who hear the record.

ANOTHER method is that of fixed gazing, of having the subject look fixedly at a small object such as a pencil held either in his own hand or in the hypnotizer's hand. Sometimes the verbal method is supplemented by so-called "passes;" that is, strokings of the face, arms, or body. Such manipulations are intended to bring about a relaxed and perhaps drowsy state, such as one may experience when in the barber's chair enjoying the manipulations of the barber. Relaxation and concentration of the attention aid in the success of the work. The continuous and monotonous repetition of simple words and acts is one of the principal factors in the technique. If the common form of sleeping hypnosis is being produced, there is simply the added feature of talk about drowsiness and sleep. No special apparatus is needed. The teacher's classroom attitude toward his class or the physician's manner of talking to his patients may be used to advantage by the hypnotizer.

THE technique of hypnotizing really is so simple that many persons at first cannot understand why it should bring about such startling changes in the subject. The common type of sleeping hypnosis is induced by a method somewhat similar to that used by a mother in soothing her child to sleep by telling a bedtime story. Then, after the hypnotic condition is induced, it has similarities to a state of sleep. The ordinary sleeper is usually immobile. His dreams consist largely of illusions and hallucinations. He may dream of long-forgotten events, and he may completely forget his dreams upon awakening. Sometimes he may walk and talk in his sleep. In hypnosis such conditions, and others, are produced artifically —made to order.

Professor Wells at his desk at Syracuse University, conversing with a student in his psychology department.

Another type in which sleep is not involved is so-called waking hypnosis. This may be compared with states of absent-mindedness in everyday life in which unusual acts are sometimes performed, with states of concentrated attention in everyday life such that sounds are not heard and pain is not felt, or with lapses of memory when even the names of best friends are forgotten. In waking hypnosis such conditions are brought about by the words and acts of the hypnotizer.

Who can be hypnotized? Perhaps all people except young children, the feeble-minded, and the mentally

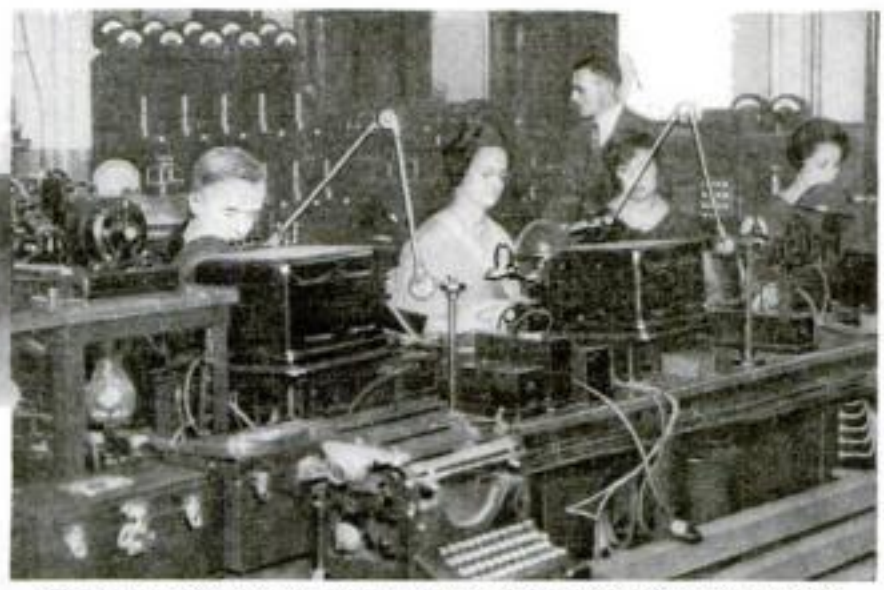
(Continued on page 161)

NEW IDEAS AND INVENTIONS

On this and succeeding pages are presented the latest achievements of inventors, including important devices and processes, together with useful methods for making and doing the old things in a better way

Speeding Up the Stock Ticker

The new stock ticker. The printing mechanism is exposed on the pedestal with the roll of tape.



Where the ticker news comes from—an interior view of the main transmitting office next door to the New York Stock Exchange.

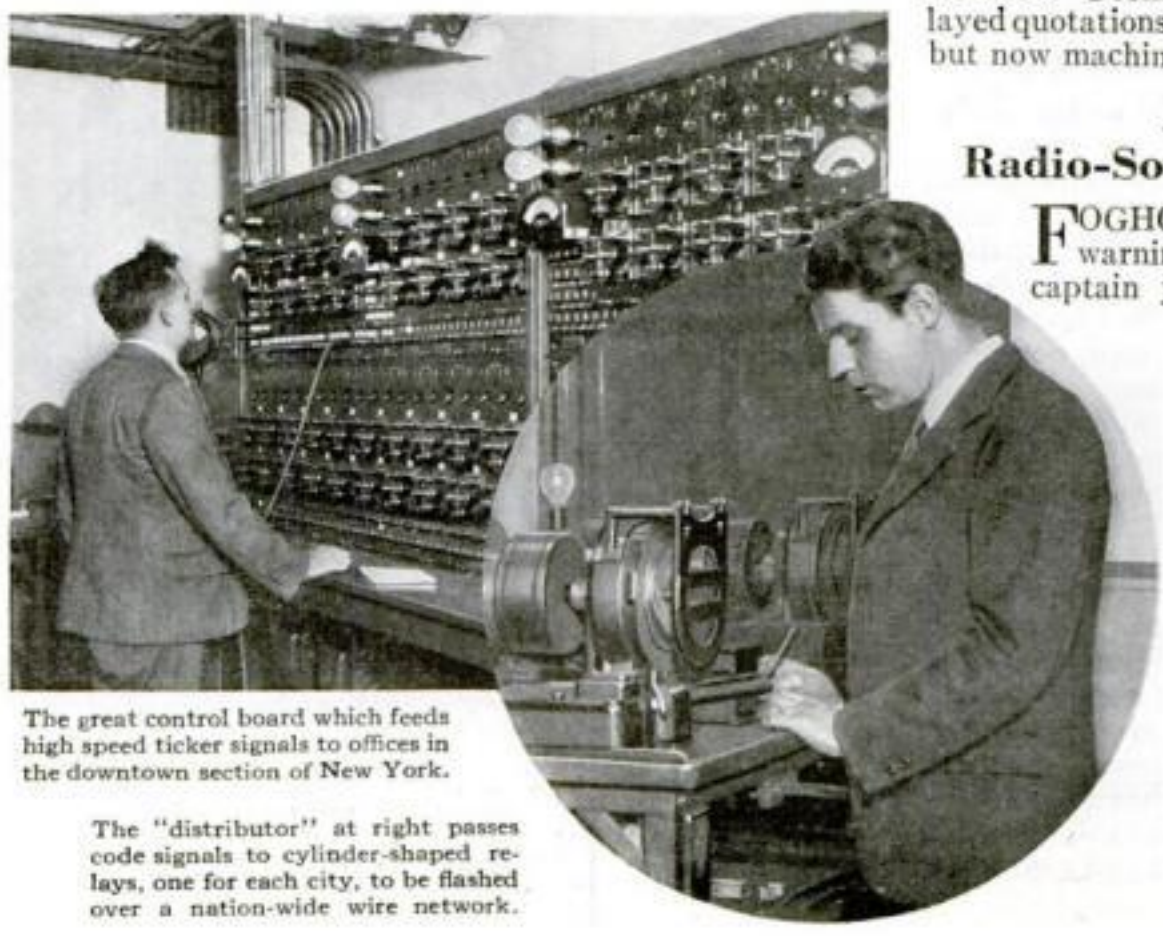
THE stock ticker is to tick no more. New high speed machines that whir instead are to be installed in brokers' offices in New York, Chicago, San Francisco, and 350 other cities in the United States and Canada. They will record by telegraph news of transactions on the New York Stock Exchange, replacing old machines found too slow for modern trading.

When more than sixteen million shares of stock changed hands in the New York market on the famous "Black Tuesday" of last October, the old-style tickers were four hours late. Many financial experts ascribed that panic partly to the inadequate reporting service. The old machines could print, on the average, 285 characters a minute; the new tickers will be able to print as many as 500.

As soon as 10,000 new tickers now on order are all installed, probably by next October, they will be speeded up to the new pace. The high speed has been achieved partly by simplification of the code sent over the wire to the ticker. Formerly seventeen separate electrical impulses were required, on the average, to actuate the mechanical brain inside the ticker and make it print a letter or a figure. Now the number is reduced to eight. These code impulses operate a mechanism much like the combination lock on a safe. One by one, they set "tumblers," or metal stops. At the final impulse an electric motor spins a printing wheel, carrying letters and figures. The "combination" stops the wheel when the proper letter or figure is in position, and a hammer springs up and prints the character on a tape. Through a second improvement, the "combination" is reset for a second letter even while the first one is being printed.

An electric motor within the ticker drives it from local power. The old models worked by clockwork, wound by electricity and requiring an extra wire from the transmitting station.

To keep pace with the high speed of the tickers, an accelerated stock reporting system will be used. In the central office two operators working side by side, instead of one, will receive quotations from the floor of the stock exchange. They will type the quotations on special typewriters that perforate tapes running past them. An almost human machine known as a "tape transmitter" translates the perforations of the two tapes into the new code impulses. The machine has six pins or "fingers" that poke through the perforations and make electric contacts. From there the impulses go to a "distributor," through which they are passed on to the relays, one for each city, that flash the news out over a nation-wide network. Formerly human operators relayed quotations at such "repeater" points, but now machines will take their places.



The great control board which feeds high speed ticker signals to offices in the downtown section of New York.

The "distributor" at right passes code signals to cylinder-shaped relays, one for each city, to be flashed over a nation-wide wire network.

Radio-Sound Fog Signal

FOGHORNS will not only give warning, but will tell a fog bound captain just how far he is from shore, if a new radio and sound wave device now being tested at Cumbrae Lighthouse, near Glasgow, Scotland, comes into general use.

At the instant the foghorn blows at the lighthouse, an automatic radio transmitter begins vocally to count off "one," "two," "three," and so on, at intervals of five seconds, the time required for sound to carry one mile. The speed of the radio waves is so great

that time required for them to reach the ship can be disregarded. Hence if the man on the bridge of the ship, with a radio receiver on one ear and the other ear open to catch the foghorn, hears the horn at the same time as the word "two," that means the ship is two miles from shore. The word "three" would signify three miles, and so on.

Fog Piercing Lamps for Railway Signals

UNUSUALLY powerful electric signal lamps that flash their colored beams for miles and are visible through fog and bad weather by day or night are being employed to supplement the familiar semaphore signals along the main lines and in the yards of American railways. The penetrating red and green lights are said to reduce the chance of a locomotive engineer mistaking or running past a signal. The photograph above shows one of the signals installed near the ground in the yards of the Terminal Railroad in St. Louis, Mo.

Steam and Diesel Engines Drive Speedy Warship

EVEN more of a surprise to the engineering world than the "pocket battleship" *Ersatz Preussen* which created a sensation last year is the *Leipzig*, a new water dragon of the German fleet capable of holding a speed of thirty-two knots or thirty-six miles an hour. The *Leipzig* is a 6,000-tonner of the cruiser type, powered with both oil and turbine engines able to work independently, and will have the capacity for a cruising range of 11,000 to 12,000 miles at a speed of eighteen knots. With both engines working together at full power she will be able to maintain the tremendous speed of thirty-two knots for a longer period than any naval vessel afloat.

She is said to be the first vessel to employ both steam and Diesel engines for propulsion. Her hull is provided with large bulges, intended primarily as an antitorpedo device, but capable of use for the emergency storage of vast amounts of oil for fuel.

New Safety Glass Resists Fire and Bullets

"XETAL," a new safety glass said to be proof against fire, splintering, or discoloring has been patented by an English firm and subjected to rigorous laboratory tests. When service revolver bullets were fired at the glass at distances of ten and twenty-five yards, it is reported, the glass was pulverized to a depth of only one thirty-second of an inch. More severe tests ensued. A powerful mercury vapor lamp was played upon the glass over a twenty-four-hour period and no discoloration resulted, a decided contrast to ordinary glass, which will be discolored even by the sun's rays in temperate zones.

Resembling ordinary glass in appearance, xetal can be made in any shape or size and in any thickness, from that of the best lens-making glass to the bullet-proof variety.

Slot Machine Deals Out Water, Soap, and Towel

TURNING on its own water supply, and handing out a wax paper packet of powdered soap and a towel, a new "automat," recently displayed at an exhibition of automatic machines in Berlin, Germany, furnishes all the materials

necessary for a thorough wash. All the customer need do to obtain service is place two ten-pfennig coins, the equivalent of approximately five cents in American money, in a slot and pull a handle. The machine will do the rest.

Rare Metal in Quantity

LITHIUM, a metal so light that it easily floats on water, is now to be available in tons instead of pounds, as heretofore. Through a new quantity production method developed by Dr. H. M. Partridge, New York University chemist, it will cost at wholesale rates only $15 a pound. Hitherto chemical laboratories have sold it at $240 a pound.

Lithium is the world's lightest metal. It weighs only one fifteenth as much as iron, and half as much as water. Silvery in color, softer than lead, and easily alloyed with other metals, it blackens and burns spontaneously when exposed to the air. Samples of the pure metal are kept under oil to keep them from decomposing.

One of its important uses is to impart sweet tones to great metal bells. It is also used in aviation to purify helium or balloon gas by absorbing impurities. Its spongelike action increases the lifting power of helium about fifteen percent.

New uses are likely to follow the production of the metal in quantity, according to Dr. Partridge.

Sun Baths on the Train

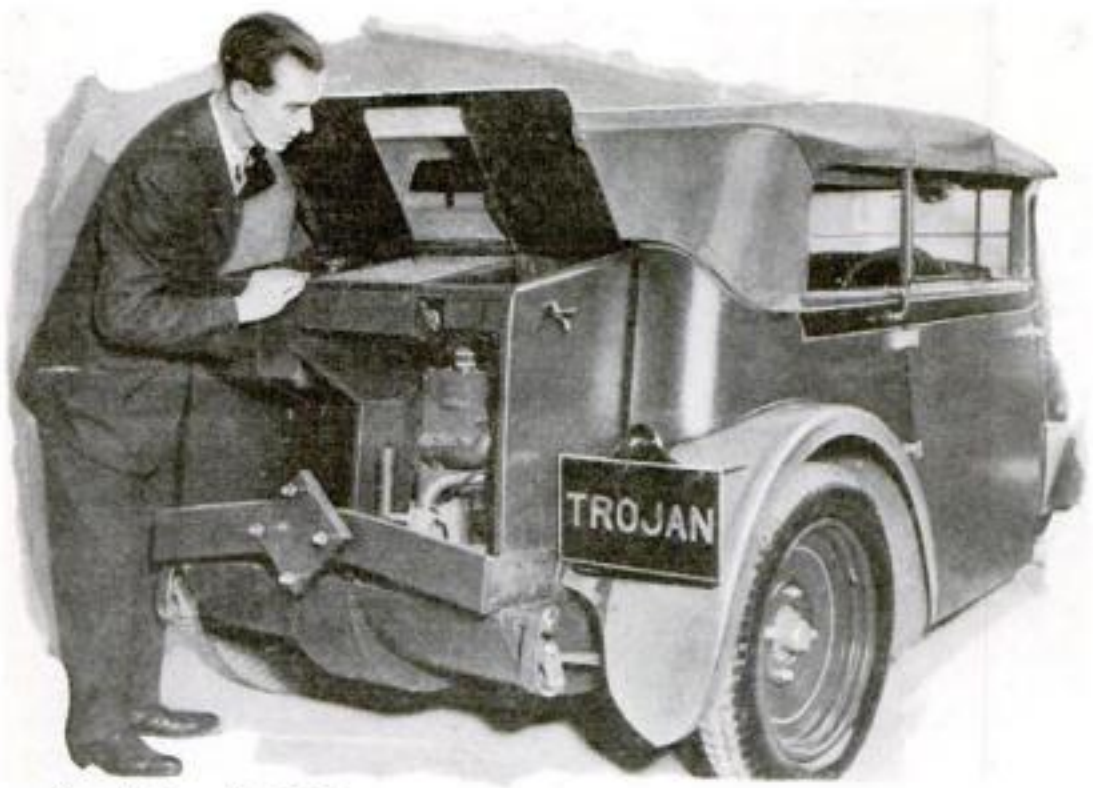
RAILROAD cars are the latest things to be equipped with windows of "health glass" which transmit the beneficial ultra-violet rays of the sun. Travelers to the south of England, bound for Cornwall and neighboring sunny winter resorts, now have available a special express service equipped with the "sun bath" cars. Thus passengers are assured of the full solar benefits of their vacation from the moment it begins.

Combination Stepladder Will Rest on Stairs

DESIGNED for a wide variety of uses about the house and yard, a new combination ladder invented in California can be made to serve as a short, straight ladder, an extension ladder, a stepladder, or one that can be adjusted to rest on the steps of a stairway.

The new accessory is built like an extension ladder, in two parts. The parts may be separated, then set together at an angle to form a stepladder, with rungs (or steps if preferred) on both sides. A special locking device fits about the top and keeps the entire structure rigid. If the ladder is to be used on a stairway, the relative height of the two parts has merely to be accommodated to the inequalities of the stairs, and the locking device holds it firmly in that position.

The new combination ladder set up on the front steps. A locking device holds it securely.



Car before the Motor

While the new front-wheel-drive car is being introduced in America, a British manufacturer has gone to the opposite extreme in the unusual model pictured above. Retaining the rear drive, its engine and radiator are placed in a trunklike compartment back of the chassis, between the rear wheels. Economy in power transmission and lessening of unsprung weight are said to result.

Surgery in the Movies—

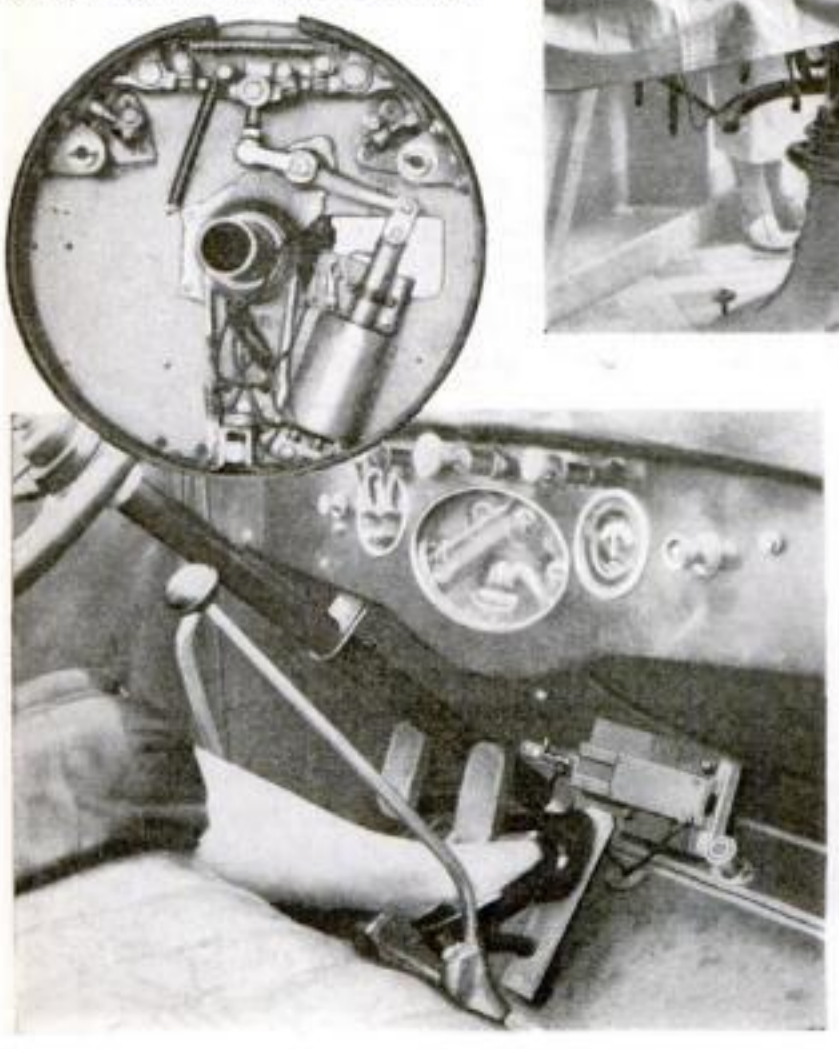
The motion picture camera and screen are playing an increasingly important part in the training of medical students. In the clinic of the University of Berlin, Germany, has been installed the special movie camera pictured above. Focused on the operating table, it makes a film record of every step in the surgeon's work. Later the film is thrown on a screen in a classroom, so that students may study the technique of the operation and make notes. Another method to the same purpose is described below.

—and by Magic Lantern

Instead of the movies, the elaborate apparatus shown at the left is used in the American Hospital in Paris, France, to reproduce scenes of an operation for students. Suspended above the operating table, it works on much the same principle as the familiar magic lantern which projects photographs or post cards on the screen. By a system of mirrors and lenses, it transfers the scene instantaneously to a screen in an adjoining room, where the students are assembled. They also hear the voice of the surgeon describing the operation.

New Electric Auto Brake

Accelerator and foot brake are combined in one pedal in the new electric brake control shown below. Toe pressure on the pedal works the accelerator; heel pressure works the brake. The latter closes a circuit and actuates an electromagnetically driven solenoid (in the circle) which, in turn, moves the cams that apply the brake. The device operates on the usual six-volt car battery.



In the Classroom

Students in the American Hospital studying an eye operation projected on the screen from the operating room. The view of the patient is greatly enlarged by the means of lenses.

High-Speed Photographs Make Whirring Wings Stand Still

"ARRESTED motion" photographs at extremely high speeds may open a new world for nature study in the future. A bee's wings, it has been computed, beat at a rate between 2,000 and 3,000 times a second. But Joseph A. Speed, A.R.P.S., of London, has caught a bee in motion with a shutter so quick that not only were the wings shown stationary in the resulting photo, but even minute details and markings of the wings were revealed.

Other achievements of his new flashlight camera include catching a swallow in flight and snapping a stoat or ermine on its leap to a limb, the photo showing the animal's feet entirely free of any part of the limb. In order to get these pictures the shutter of the camera clicked within one five-thousandth of a second. The marvel of the camera mechanism lies in its ability to time the flash exactly with the shutter.

The photos were first publicly shown at the recent seventy-fourth annual International Exhibition of the Royal Photographic Society in London.

This rapid motion photo caught an ermine in the act of leaping to a limb. Notice that not one of the animal's feet is touching the tree branch.

A remarkable flashlight photograph of a swallow in flight, made possible by the fast camera shutter. The wings appear stationary.

Welded Steel Floors for Higher Skyscrapers

IN THEIR efforts to design higher skyscrapers architects are limited by an enormous dead load of flooring. To lessen this unnecessary burden on the building's supporting structure, a new type of floor panel construction has been invented by steel engineers. This revolutionary flooring, demonstrated recently before the American Institute of Steel Construction, is designed to act as a solid steel girder embracing the whole girth of a building, preventing tortional quirks and reducing the danger of high wind or earthquake action. So much lighter is the new flooring than the old, that for a seventy-five-story building it is calculated to save 2,000,000 pounds of dead load on the foundations for each column. This, it is said, would permit an increase of twenty-five percent in the height of the building. Thus may the dreams of 100-story buildings become a reality.

The new so-called "battledeck" flooring consists of plates "stitched" by a new automatic arc welding machine comprising a self-propelled vehicle carrying a wire feeding device, a reel of welding wire, and arc welding apparatus.

Dustless Garage Cleaning

WHEN garage floors become covered with dust and spotted with oil, a sprinkling of sawdust or sand saturated with kerosene assists in the cleaning. It prevents clouds of dust from rising during the sweeping and the kerosene removes most of the small oil spots.

Knockdown Desk and Seat for the Schoolroom

A LIGHT combination desk and seat, which can be adjusted to suit any child from four to ten years of age, has been devised by a California inventor, who claims that the equipment weighs at least ten pounds less than the present standard school desk, is just as serviceable, and costs half as much.

The top of the desk consists of a shallow box of thin wood, made with a blackboard on the outside of the lid for small children and with plain top for larger pupils. At the upper end of this lid rises a holder for drawings or other material the child may have to copy. Inside the box are spaces for paper and writing utensils. The box itself may be closed with a catch and carried as a school box, to and from home, if desired.

Seat, legs, and standard to hold the desk consist of five flat pieces. Mortises and tenons bind the whole together solidly so that it may be moved as easily as a standard desk.

A small schoolboy copies a drawing on the blackboard lid of the new knockdown desk.

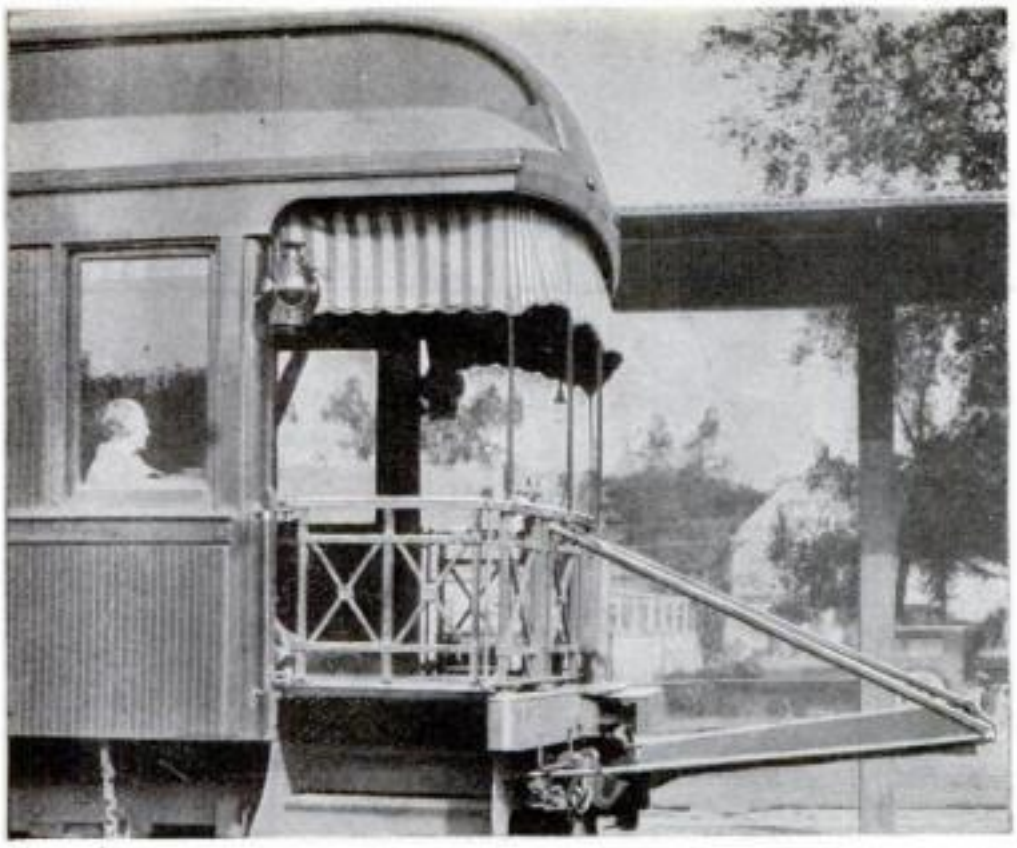
Tunnel Lined with Wood

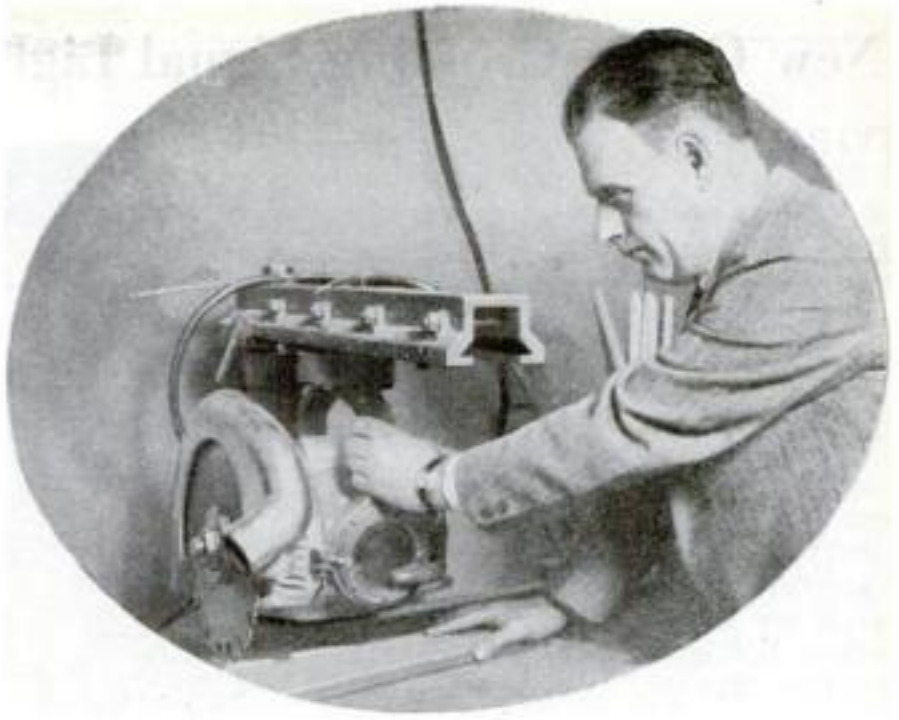
YELLOW pine lumber has entered the field of tunnel engineering with the building of the new water conduit from the River Rouge to the Ford Motor Company Plant in Detroit, Mich. From the bottom of a seventy-foot shaft twenty hydraulic jacks are driving an enormous steel shield horizontally through the earth to make a circular tunnel nineteen feet in diameter. As the tunnel grows behind the path of the advancing shield, it is lined with long yellow pine boards, held in position by the pressure of the earth. Eighty thousand feet of board are so installed daily.

Heretofore the material ordinarily used for such tunnel lining has been cast iron. The chief advantage of the new tunnel material is its economy.

Chemicals to Remove Snow

THE problem of snow removal in large cities may be solved by chemistry after this year. Chemical methods of breaking up snow and ice along the gutters have been tried out this winter, particularly in the Boroughs of Manhattan and Brooklyn in New York City. In the latter borough, following a recent storm, four ice-caked streets were sprinkled with pellets of calcium chloride, the melting effect of which was said to be noticeable within a few hours. The manufacturers of the chemical claim that the pellets will drain snowdrifts down the sewers.

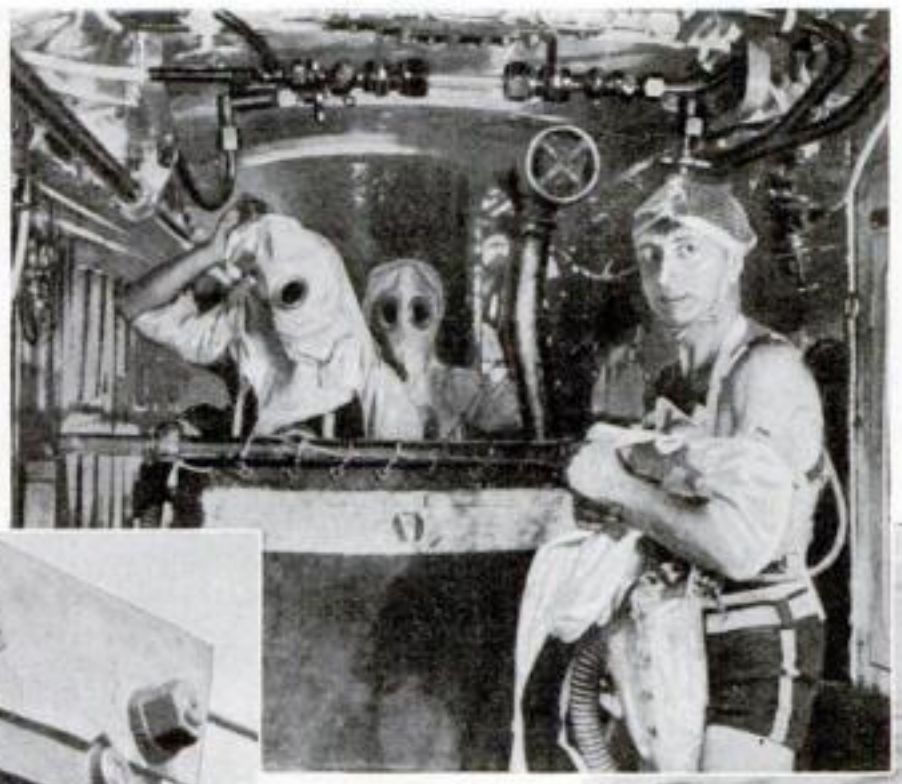




An All-Purpose Saw By changing blades, this new adjustable saw can be used to cut stone, iron, steel, or fiber, as well as wood. It also will cut at any desired angle, or make circular grooves. The circular blade is attached to an arm which moves on ball bearings.

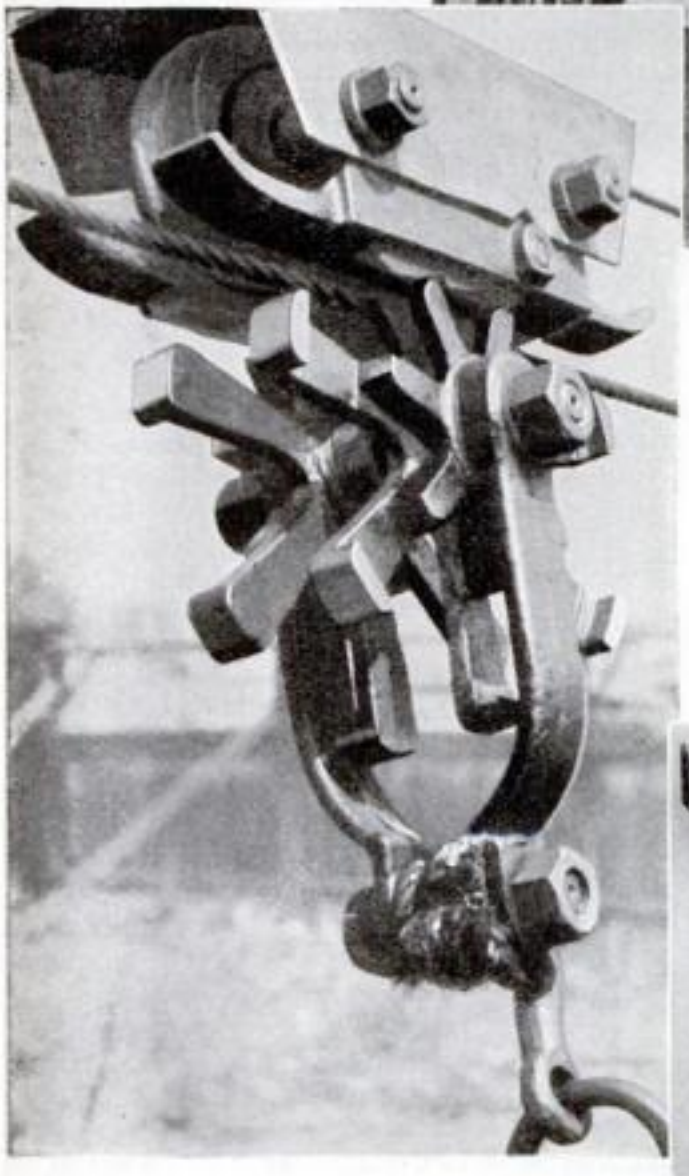
Dust Catcher

Passengers on crack trains of the Dominion Atlantic Railway in Nova Scotia can sit on observation platforms without being choked by swirling dust. A new dust catcher consists of a rectangular frame of iron pipe covered with a screen of canvas and attached horizontally to the end of the observation car a foot below the floor level. Of light construction, it can be detached easily and quickly for cleaning.



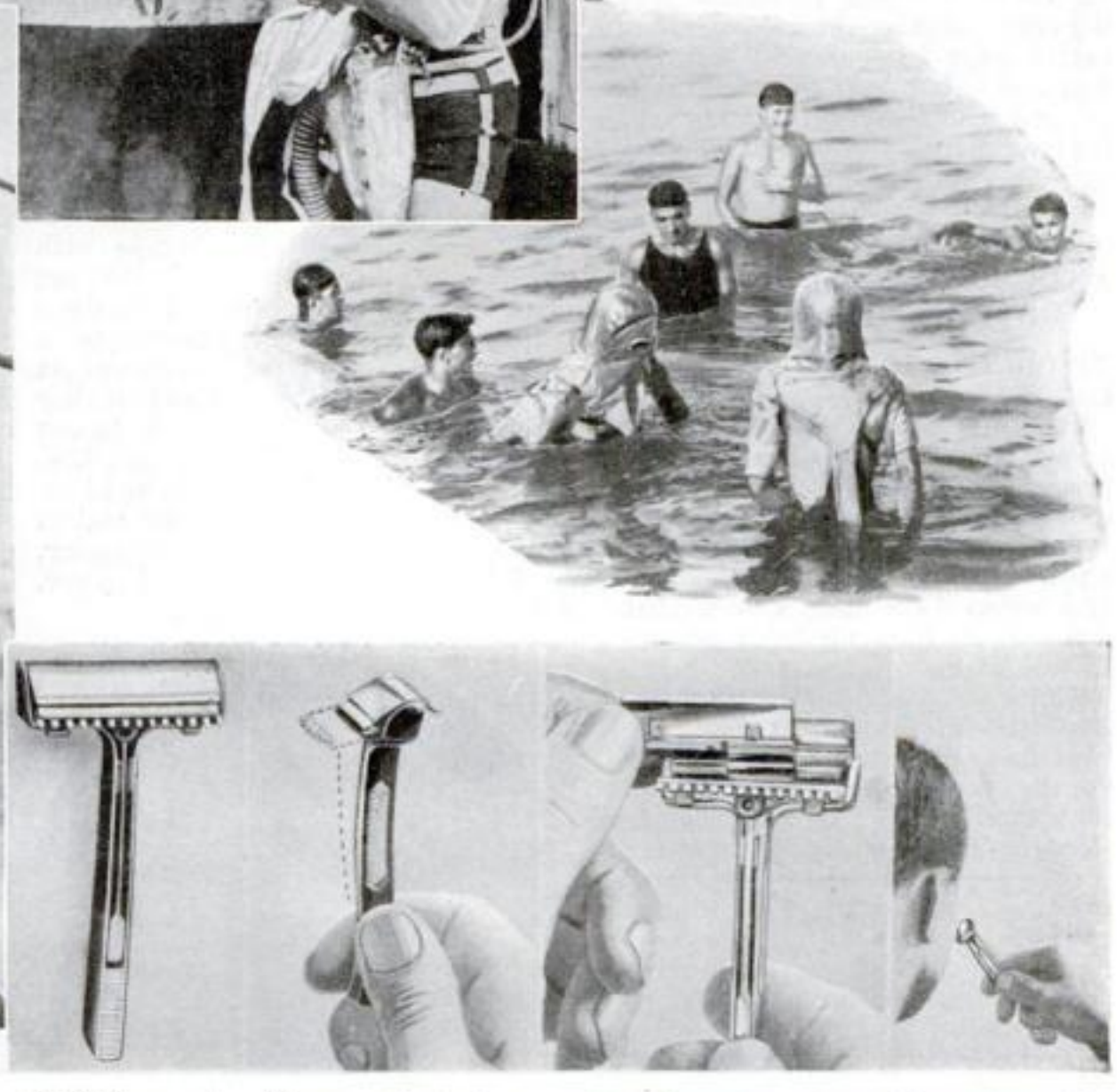
Submarine Rescue Tube

Sixty-five feet undersea, the crew of the Italian submarine *S-17*, in recent tests near Spezia, Italy, entered a newly invented safety tube and shot to the surface in six minutes. At sixteen feet depth, others of the crew escaped wearing only bathing suits. The tube leads to an escape reservoir on the submarine, where water is held back by air pressure. At left: Donning diving suits for escape from the submarine. Below: The members of the submarine's crew reaching the surface.



A "Step-Over" Trolley

Moving metal "fingers" that suspend the load from this new cableway trolley are said to lift a five-ton load over crosswise cable supports, thus solving satisfactorily an "impossible" problem.



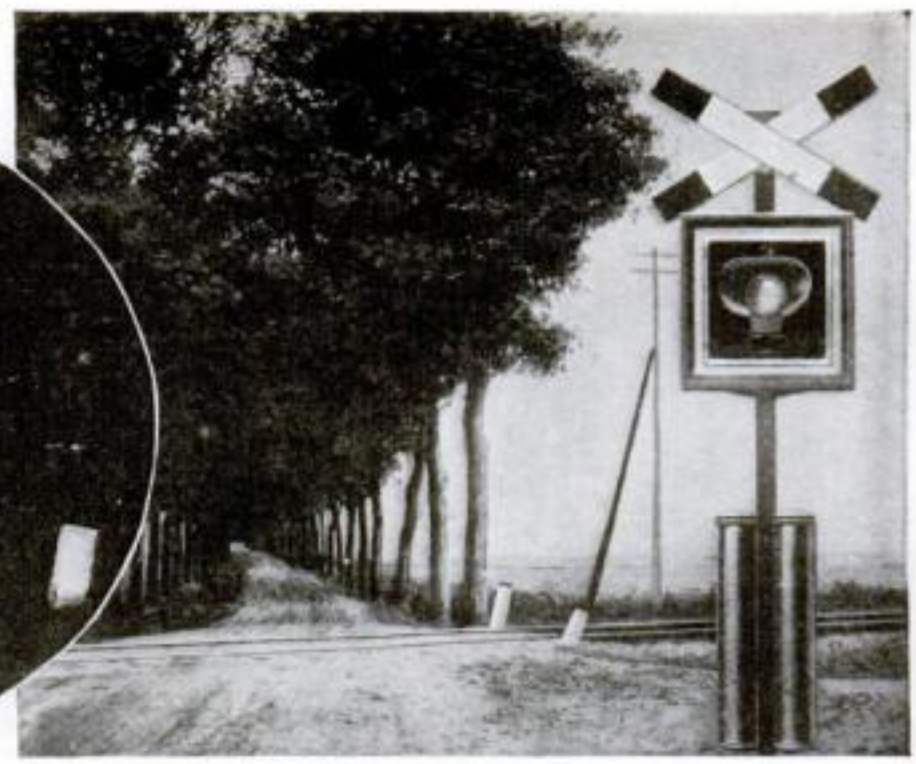
Self-Sharpening Razor All the shaver need do to keep a keen edge on this novel razor, the inventor claims, is to shake it once in a while; for it combines in one unit a blade, a hone, and a strop. The shaking is said to move the blade edge over a sharpening surface to which a special chemical abrasive has been applied. These views show the new safety razor and its self-sharpening mechanism.

New Grade Crossing Signal Light

TO REDUCE the increasing number of fatalities from automobile-train collisions, the German government recently introduced special railway signal lights for automobile drivers at grade crossings. White and red are the colors used, corresponding to the green and red lights ordinarily used for railroad signals.

When the track is clear, a continuously-blinking white light informs the motorist that he may cross, giving a positive assurance of safety. An approaching train makes an electric contact that changes the light to a red flash signaling "danger." Concentrated by a screen, the light is plainly visible by day and night.

The crossing signal at night. Its brilliant white light changes to red when a train approaches.



A daytime view of the new warning signal installed at a grade crossing in Germany. It contains powerful lamps and reflector.

Steam Heated Gardens

UNDERGROUND steam heating plants may be the next item on the list of agricultural implements. Heating the soil has been found by an English chemist, Dr. W. F. Bewley, Director of the Experimental and Research Station at Cheshunt, to destroy pests and diseases and to increase soil fertility. The method involves heating the soil for about half an hour at the temperature of boiling water. Heavy soils require more heating than light, sandy soils. Disease-producing bacteria and fungi are said to be destroyed without killing the beneficial soil bacteria. The heat also breaks down complex chemicals into simpler ones useful for the soil bacteria.

Heating must be thorough, says Dr. Bewley, and is best carried out by running a current of steam through the soil. Baking is all right but dangerous, as overbaking leaves the soil dry and ruins it.

Advocates Flying Clinics for Frayed Nerves

"AIR CLINICS" for nervous and run-down patients are suggested by C. L. Julliot, French lawyer. With the reported approval of the medical faculties of France, he proposes airplane rides as a tonic for the nerves. Every hospital might maintain an airplane or two for the use of its patients.

Physiologists have long known that brief visits to the tops of habitable mountains cause changes in the human body, particularly in the blood. However, there is little quantitative data as to the proper "dosage" of high-altitude exposure, or the exact effects it produces upon human beings.

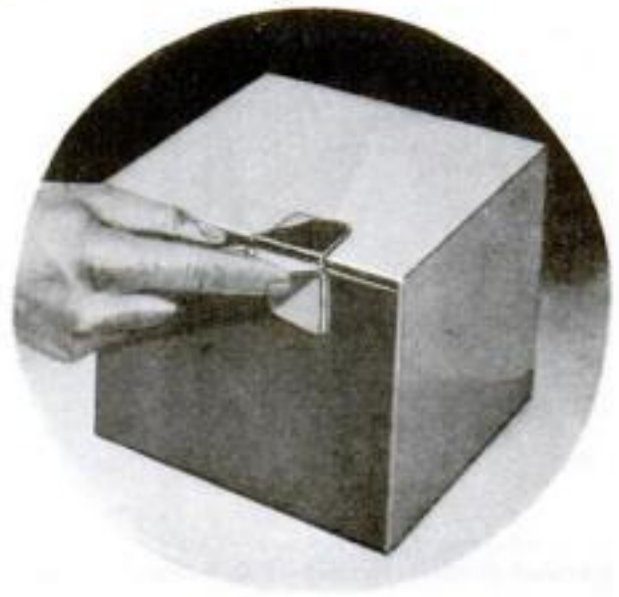
Aside from high peaks, there are only a few places in the United States where such tests could be made. The United States Bureau of Standards at Washington, D. C., has an "altitude chamber" in which it now tests the effect of high altitude upon motors. Another place where upper-level effects could be duplicated is the remarkable globe-shaped hospital at Cleveland, O., where diabetic patients now can live in an atmosphere of more than normal pressure. Here powerful vacuum pumps could as easily maintain a pressure below that of the atmosphere.

When the exact effect of such treatment upon the human body is known, "flying clinics" may provide this tonic of the upper air and add the zest and thrill of aviation. Not only airplanes, but dirigibles of large passenger capacity might be fitted to fill any doctor's prescription for "high living."

Found—Easy Way to Open a Cardboard Carton

A HANDY tool for slashing open a cardboard or fiber carton with a straight line cut, so that the container may be used again, is the recent product of a New York City manufacturer. Simple and speedy in operation, it can be used to open either small packages in the home or large shipping boxes in stores and other business houses.

The tool consists of a handle with spreading wings at one end, between which is inserted a blade, not unlike a razor blade, that is held secure by a spring. The wings of the handle are set at right angles to each other, so that they fit over the edge of the carton to be cut and guide the blade in a straight line. When a blade is to be inserted, one of the wing flaps is raised, revealing the spring. The blade is inserted beneath the spring, the flap is shut down and locked in place, and the tool is ready for work.



Sliding the razor-bladed tool along the rim cuts off the lid without damaging the carton.

Ship-to-Shore Telephone Service Opened

THE first "ship-to-shore" telephone service by radio was opened on a recent eastbound voyage of the steamship *Leviathan*. Seated at his desk in the offices of the American Telephone and Telegraph Company on Broadway, New York City, Walter S. Gifford, President, took up the phone and asked for "the United States Liner *Leviathan*, somewhere at sea." His voice was carried through a new transmitting station at Deal Beach, N. J., thence to a station at Forked River in the same state, and finally reached the radiophone receiver of the great liner 200 miles out on the Atlantic.

Other calls were put through from New York, Washington, D. C., Atlantic City, N. J., Indianapolis, Ind., and several other cities at the rate of seven dollars a minute.

With good weather conditions it is claimed that the *Leviathan* should be able to establish phone contact with the shore at a range of 1,500 miles. Telephone officials say that the vessel will offer twenty-four-hour phone service whenever it is within range of American transmitting service. President Gifford predicts that eventually every ship on the seas will be linked by radio to the shore and thence by wire to any telephone.

Speedway Atop a Railroad

ABOVE the twenty-six-mile stretch of the Grand Trunk Railway running from Detroit to Pontiac, Mich., a four-way automobile toll road mounted on steel pillars will be built. This is said to be the first instance in which the air rights of a railway have been used for automobile traffic speedway purposes in the United States. The speedway will enable the motorist to cover the twenty-six-mile distance easily in thirty minutes. It will pass over all intersecting streets and railroads, will be encumbered by no traffic lights, and will be zoned. Traffic will enter and leave by way of ramps built at important intersections. The first step in the construction of the roadway will be the electrification of the railway underneath at a cost of $100,000,000.

Vacuum Gear Shift

The touch of a finger tip on a lever just below the steering wheel operates a new auto gear-shifting device which works by vacuum and does away with the usual shift lever. It is the invention of J. H. Newmark, automotive engineer of New York City. The vacuum required for operation is ingeniously supplied from the motor intake manifold. In the photo above a young woman demonstrates its ease of operation in conjunction with the clutch. The mechanism, it is said, can be installed in almost any car in place of the standard gear shift.

Home Talkies Arrive

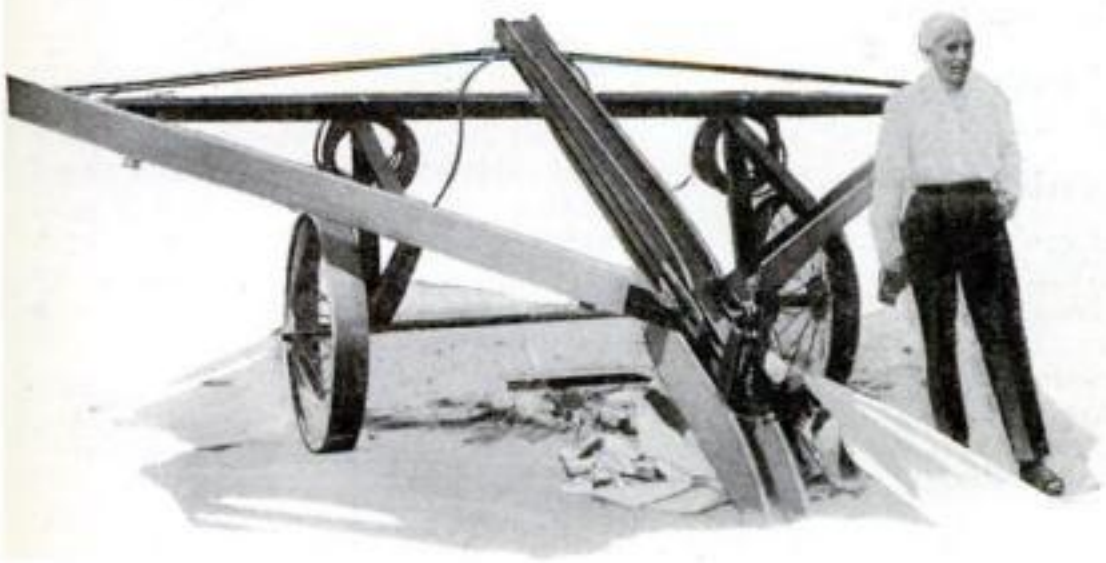
An amateur talking motion picture outfit in combination with a radio receiver is the latest thing in home entertainment. Produced commercially, the talkie apparatus comprises a motion picture projector and phonograph. A 16-millimeter picture film is carefully synchronized in movement with the phonograph disk on which the voice is recorded, the timing being accomplished by an ingenious electrical hook-up.

Rogue's Gallery Photos Standardized

More certain identification of criminals is the purpose of this new camera designed to standardize photographs by automatic control of lighting, exposure, and focus. Strong, diffused light assures clear pictures and avoids distortion of the face.

Santos-Dumont Invents Life-Line Catapult

Resembling a giant crossbow, a new life-line catapult has been devised by Alberto Santos-Dumont, the Brazilian aviation pioneer who made the first airplane flight in Europe in 1906. He is pictured below with his invention placed in firing position. The "string" of the bow consists of two wooden arms which, when drawn back, bend heavy flexible bands that form the bow. The missile is a slug to which the life line is attached, and which is shot along a groove in the central shaft when the bow is sprung.



The Car Makes Its Own Gas

The idea of making a motor car manufacture its own gasoline is embodied in this apparatus devised by D. E. Fowler, of El Paso, Tex., (above) for the use of crude oil as motor fuel. It consists of a cylinder attached to the engine and acting as a portable still for producing gasoline by the "cracking" process. Another new crude oil device is shown on page 37 of this number.

Shotgun "Camera Cartridges" Check Sportsman's Aim

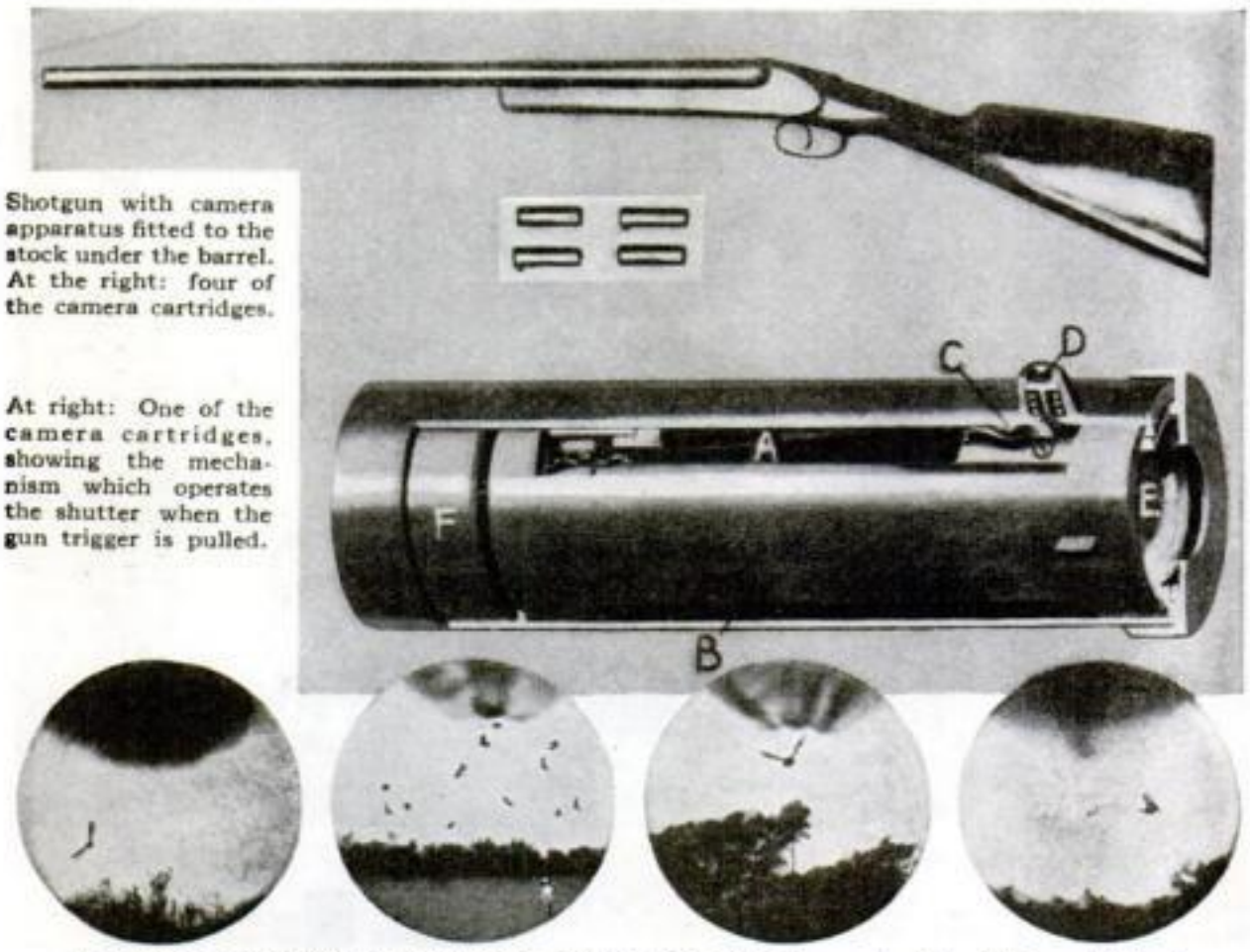
A CAMERA attachment for a shotgun is the latest invention to enable a sportsman to test his aim as well as the accuracy of the weapon itself. At the touch of the trigger the gun fires a "camera-cartridge" as well as the usual charge of birdshot. The camera apparatus, fitted to the stock and lying under the gun barrel, contains four small cartridges each capable of taking a miniature photo about seven sixteenths of an inch in diameter. In the upper corner of the photo appears the arc of a circle, representing the end of the barrel. The position of the target in relation to this cloudy arc indicates the probability of the shot charge reaching its mark.

The illustration shows how shot and camera shutter are synchronized. A catch (*D*) connected by wire to the trigger of the gun releases the camera shutter (*A*) from a small notch (*C*) when the gun trigger is pulled. The shutter, operated by a rubber spring (*B*), exposes a sensitive plate (*F*) through a lens (*E*). An ultra-rapid photographic plate must be used.

To determine the accuracy of the aim by means of the final negative, an intricate calculation is needed, for when the exposure is made the shot charge still has thirty yards to travel, making a difference of about one fifteenth of a second. And the position of the "killing circle" with respect to the bird can be figured out precisely only if the speed of flight of the bird is known. The photos, however, are said to give a close enough estimate for practicable purposes.

Shotgun with camera apparatus fitted to the stock under the barrel. At the right: four of the camera cartridges.

At right: One of the camera cartridges, showing the mechanism which operates the shutter when the gun trigger is pulled.



Enlargements of cartridge photographs. Left to right: Aim too much at the right; partridges in the "killing circle"; accurate aim—the bird in the "killing circle"; aim too much at the left.

Cooling the Telephone

A "REFRIGERATED" telephone receiver, designed to take the discomfort out of lengthy conversations in hot weather, has been invented by an English engineer. Made of special material, it is said to contain a new kind of freezing mixture which becomes perceptible only when the warmth of the ear is applied to the casing.

Brush Holds Shaving Kit

A NOVEL convenience for the traveling man is a "knockdown" shaving brush with removable bristles and carrying shaving cream and powder within its handle. In the cap that screws over the butt of the handle fits a little round case containing powder and puff. Cream, in a tube within the handle, is released by pressing a button on the handle's side.

The shaving brush kit with cap of the handle removed, showing the powder case and puff.

New Electric Typewriter Prints Whole Phrases

AN ELECTRIC typewriter designed to print words and phrases in addition to single letters is the invention of Clyde C. Balston, of New York City, who claims it will write a business letter five to twenty-five times faster than the usual machine. It is designed especially for billing and office work. More than ninety percent of all the words required for business correspondence may be printed as words, the inventor claims. Other words may be typed out in the usual manner on a standard keyboard with which the machine is equipped in addition to its special keyboard. The new typewriter is reported to be practically noiseless in operation.

To form the words, electrically-rotated bands of type are stopped by means of selectors controlled by the keys. Two keys are pressed down to form each word or phrase. One brings the selecting mechanism into play and the other stops the rotating bands of type at the right place to spell the word. Thus phrases such as "by return mail," "My Dear Sir" and "Very Truly Yours" can be written, it is explained, with no more effort than is now required to type a word containing two letters.

An Ingenious Lock Nut

A NUT that can't be shaken loose, yet comes off easily with the turn of a wrench, has been invented by a French mathematician, H. L. Dardelet, and is now manufactured in this country. It is used with a special bolt. The harder one tries to twist it, the harder it grips. Yet press down ever so slightly, and it twirls off in a jiffy.

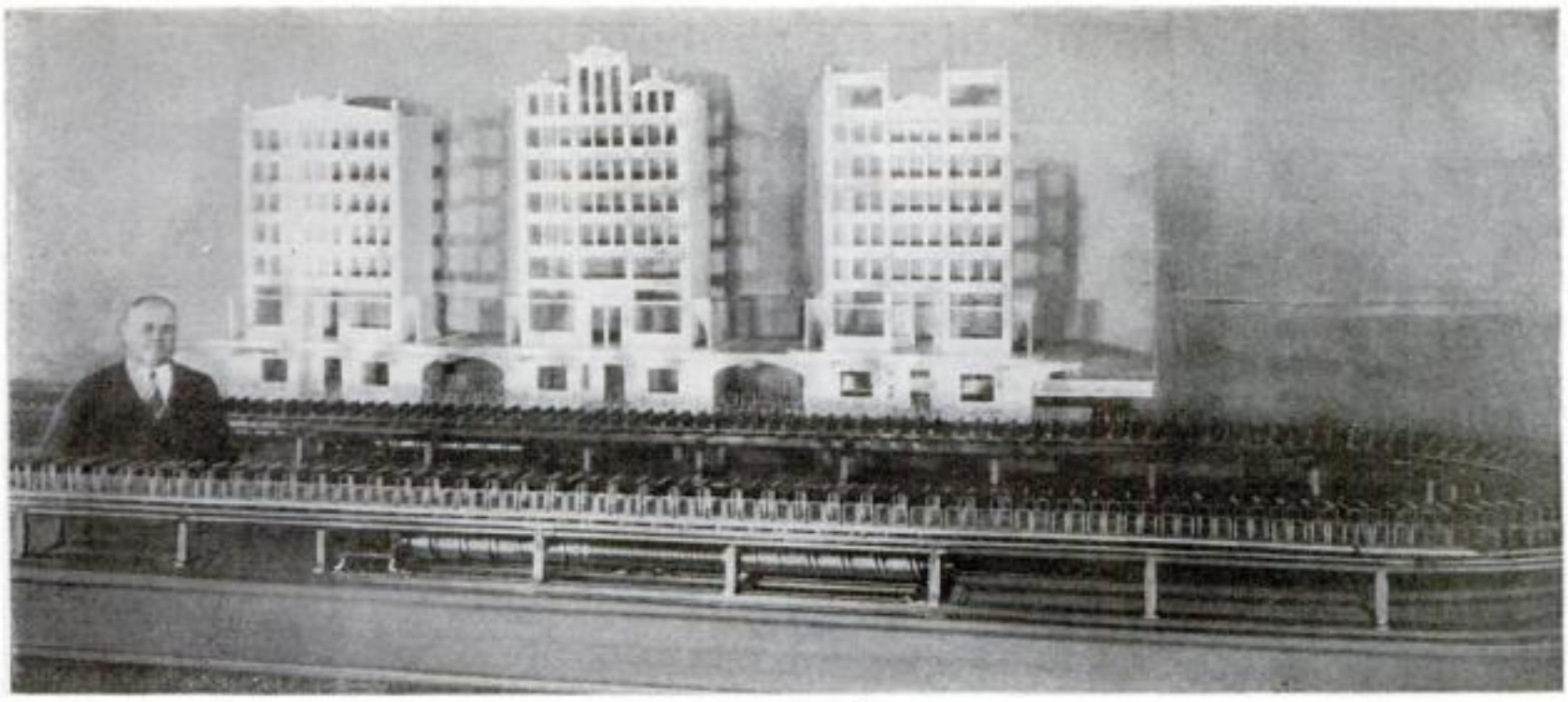
The secret of the nut lies in the slight taper given the edges of the square-cut threads, and a corresponding slant of the bolt's shank between its threads. The effect is that the nut spins loosely into its position. Then a couple of turns with a wrench actually force it onto a thicker part of the bolt; it is as if it had been rammed part way up a bolt too big for it, although not forcibly enough to damage the steel. It locks so firmly that no lock washers, cotter pins, or similar devices are necessary. However, a reverse turn with a wrench relieves the locking pressure and removes the nut readily whenever desired.

Expedition Sets Sail in Vibrationless Yacht

"SMOOTH sailing" is the motto of an expedition of scientific and business men which recently left the Tebo Yacht Basin in Brooklyn, N. Y., for the Galapagos Islands. The new vibrationless yacht, *Olive K*, owned by Charles F. Kettering, head of the General Motors Research Laboratory in Detroit, is the ship of adventure which the expeditionists are trusting to keep them from seasickness and jiggling bunks.

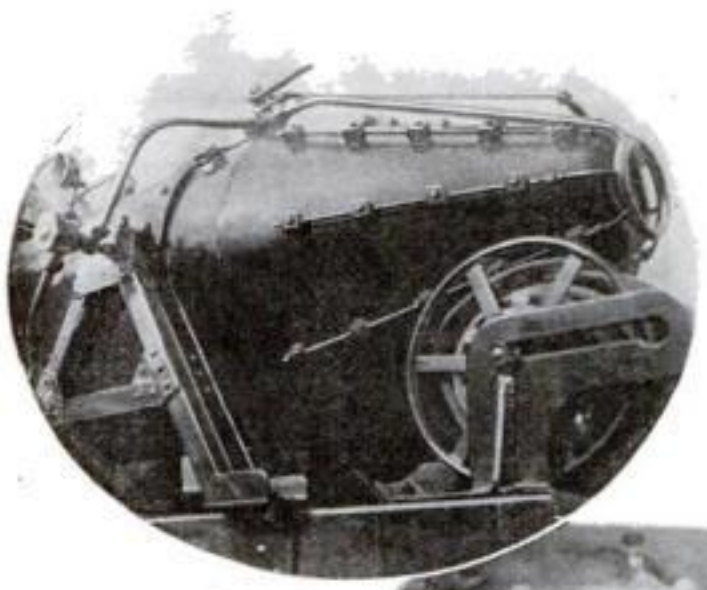
To eliminate vibration the two propellers are synchronized, or timed together. Alternating current generators are built into the flywheels of the two Diesel engines, with controls so arranged that they lock the engines electrically and make them run at exactly the same speed. To prevent pitching and rolling as far as possible, the ship is equipped with a gyro stabilizer.

POPULAR SCIENCE MONTHLY will be glad to supply, whenever possible, the names and addresses of manufacturers of devices mentioned on these pages.



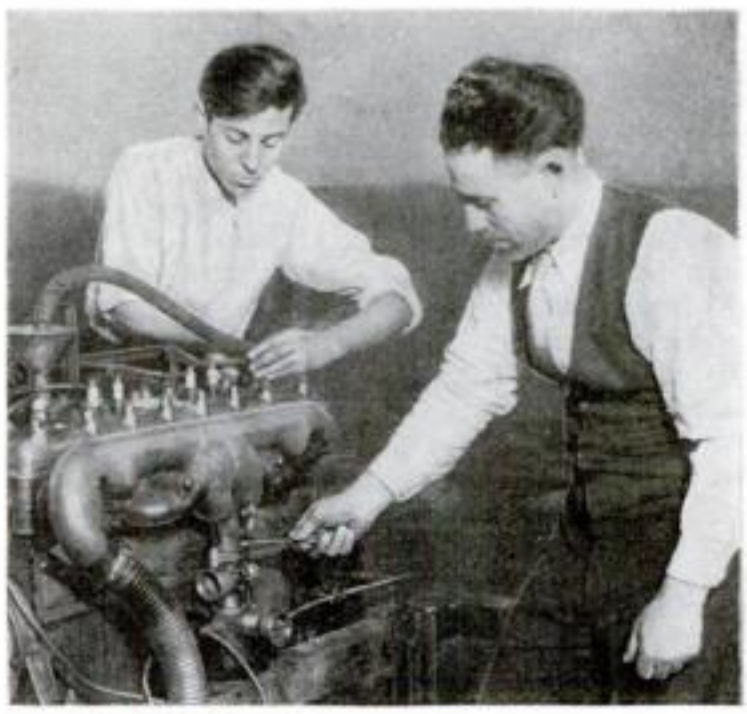
Subway Moving Sidewalk

Above is a working model of a new nonstop moving sidewalk system demonstrated by its inventor, Herman E. Taylor, traffic supervisor of Detroit street railways. It comprises two worm-driven belt conveyors, one carrying seats and moving at a constant speed of 20 to 25 miles an hour, the other starting at ¾ mile an hour and accelerating to speed of the other in 9 seconds. Passengers would step from one to the other. The system would be underground.



Fighting Fires with Streams of Powder

Instead of water or liquid chemicals, Germany 's newest type of fire engine pumps through the hose lines a harmless carbonic acid powder which is said to smother flames without damage to fixtures and goods. The powder pumping machine is pictured in the oval above. At the right firemen are seen "powdering" a blaze in an outdoor demonstration of the method.



Fuel Oil Carburetor

Joseph Graziano, New York shoemaker, has devised a carburetor which, he claims, permits use of fuel oil instead of gasoline in motor cars. It includes special spraying and heating chambers for vaporizing the heavy oil. Photograph shows the inventor and his son installing the device.

An Eight-Ton Armful This motorized "lumber buggy" supersedes the horse-drawn two-wheel cart in Pacific Coast mills to speed the transportation of lumber about the mill yards or to shipping docks. Straddling a pile of lumber, it lifts it bodily at the touch of a lever and carries it away at a speed of 15 miles an hour. The load pictured above contains 5,600 feet of lumber.

Featherweight Office Furniture

Auminum is the latest material used for desks, chairs, and other office equipment. This chair, weighing only six pounds, can be lifted with one finger. The new furniture is fireproof, in addition.

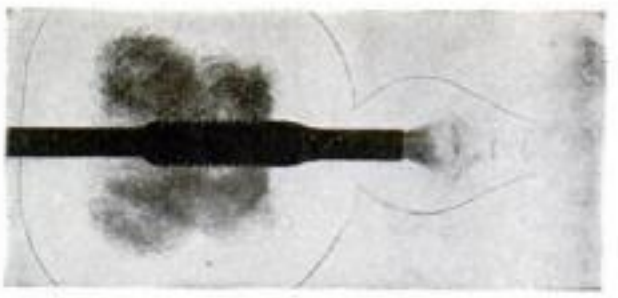
Takes the "Kick" Out of Rifle or Shotgun

A NOVEL "compensator" for the reduction of recoil peculiar to high powered rifles and shotguns has been introduced to sportsmen by a Connecticut manufacturer. It is claimed that it will reduce recoil fifty percent. Fitting on the front of the gun muzzle, it seems to get around the established physical law that action and reaction are equal, at least so far as the effect on the gunner's shoulder is concerned. All that the latter should feel is a mild, gradual push—instead of a vigorous "kick."

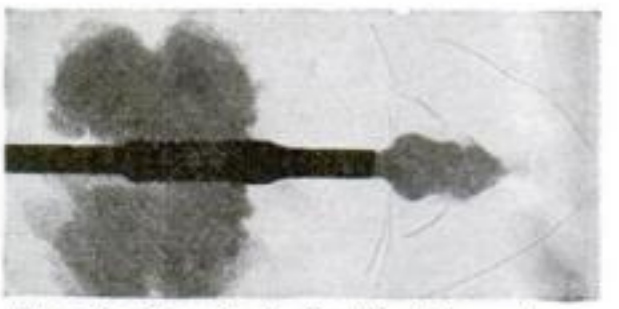
Two of the new recoil suppressors, the large one at the left for shotguns and the smaller one for rifles.

The secret of the shock absorption lies in what happens to the gases at the muzzle with the compensator attached. Gases issue from the muzzle of a military rifle at a pressure of about 5,000 pounds per square inch; from a shotgun at about three fourths of a ton to one ton per square inch. Within the body of the compensator the gases expand, the bore of the compensator being larger than that of the arm, and the expansion reduces the pressure. The remarkable high speed photos shown here illustrate how the gases escape sidewise through side cuts or ports of the compensator, instead of following in the direction of the bullet or shot charge. The velocity of the gas is such that probably one half of it is carried forward and compressed by the slope of the forward end of the torpedo-shaped compensator. The resulting compression is accompanied by a forward reaction of the compensator body. This forward motion, or pull, tugging against the urge of the gun to kick the man's shoulder, reduces the recoil.

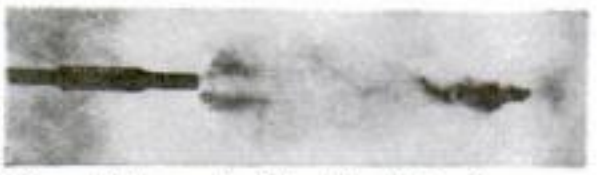
A shot charge, leaving the barrel of a shotgun without compensator, is pancaked by pressure.



A shot charge passing through the compensator tube. Notice the gases escaping through ports.



Here the charge is leaving the tube, and gas escape is at maximum, counteracting the recoil.



Clear of the muzzle. The shots in the charge are perfectly bunched, without signs of scattering.

The shot charge in flight forms a uniform, compact pattern. The powder wads are left behind.

Household Ice Boxes May Go "Dry," Too

THE family ice man, vanishing before the spread of mechanical refrigeration, may come back—with a load of "dry ice" on his shoulder.

But his calls will be less frequent, according to Walter S. Johnson, one of the pioneers in developing the new refrigerant, who made the prophecy before the American Society of Refrigerating Engineers recently. A sixty-pound cake of the new substance, costing about seventy-five cents, will keep a household ice box at thirty to forty degrees Fahrenheit for a week, he declared.

This product, snowlike in appearance, is much colder than ice—about a hundred degrees below zero. Recently it has been used extensively for shipping ice cream and frozen fish and meat products, and, because of its compactness, it is preferred for the ice boxes of passenger airplanes that serve meals in the air.

Burnt Toast Packed with Invisible Diamonds?

THE possibility of making diamonds from burnt toast is suggested by Dr. S. Paramasivan, a brilliant physicist of Calcutta, India. Diamonds are carbon atoms packed extremely tight. The only difference between diamond carbon and lead pencil carbon is that the atoms in the latter are packed very loosely, like the crumbs of a sponge cake. Various kinds of carbon have different magnetic properties. Dr. Paramasivan is an expert on these properties. To his surprise he finds that many kinds of carbon, such as that of burnt sugar or a smoky flame, act magnetically like that of diamond carbon instead of like that of the graphite carbon of lead pencils.

Apparently the carbon of burnt toast is made up of myriad tiny diamonds too small to be seen by a microscope, and might be turned into gems if someone were clever enough to put them together in the right way. But try and do it!

Automatic Device Records Rhythm of Heart

THE hack work of laboratory workers in biology and physiology may be considerably lightened by the use of a time-saving invention recently perfected by a banker-scientist of Tuxedo Park, N. Y., A. L. Loomis, and described at a meeting of the National Academy of Sciences. It is a mechanism to record automatically natural rhythms of any kind, such as the heartbeat, the nerve impulse, or the flashing of a lamp.

The living body is a network of such rhythms. Prof. E. N. Harvey, of Princeton University, made extensive studies of these rhythms with the aid of the new device by isolating a turtle's heart in a special liquid medium and recording the variations in its beat over a period of many hours. (A turtle's heart will beat indefinitely after removal from the body, sometimes as long as thirty-six hours.)

But here is the point of the invention. Formerly, if Professor Harvey had wished to make observations on the heart action he would have had to stay in the laboratory and take all the notes himself. Now the Loomis apparatus can take all the notes for him. It is geared in such a way that ten successive beats are recorded by a pen-drawn line indicating the time of the action. At the finish of ten beats the pen goes back to the zero line and starts recording again. The instrument can prolong this process for any length of time, while the laboratory worker may adjourn to lunch, a game of tennis, or anything else that pleases him.

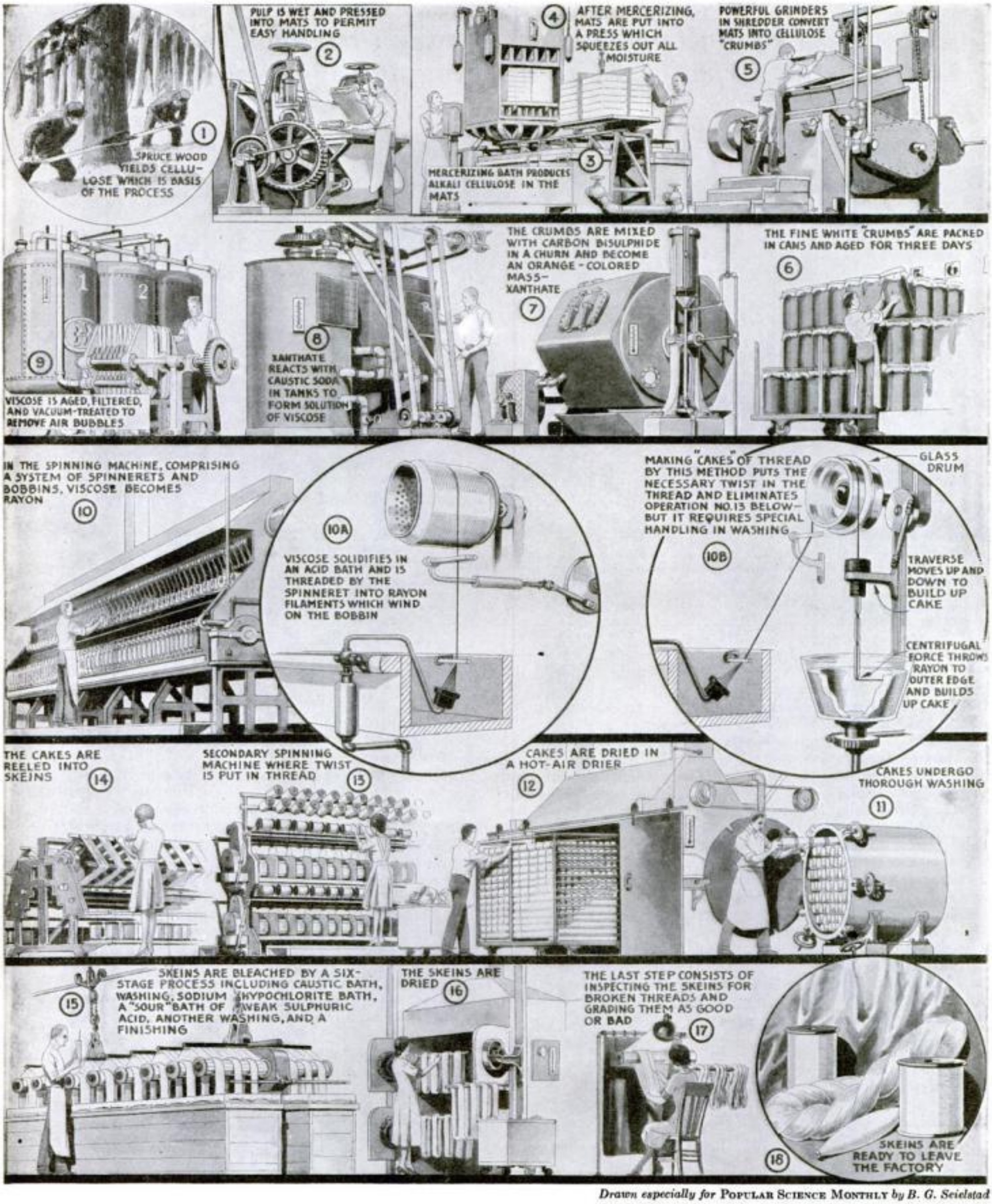
Studying the fluctuations of bodily rhythms gives valuable data to physiologists. The effects of drugs on the heart action is an instance of the problems that may yield their answers by such methods as Loomis' mechanism makes possible.

Alcohol from Watermelons

ON THE banks of the Volga River by the town of Stalingrad, Russia, a new factory has been established for the manufacture of syrup from the pink pulp of watermelons. This new product, known as "Nardek," will have its uses split in half; the better grades of the syrup will be used in cooking or confectionery, and the poorer grades utilized in the manufacture of alcohol.

Looks as though "vodka," the Russian whisky, would be made from watermelons instead of from corn after this.

From Wood Pulp to Rayon Silk



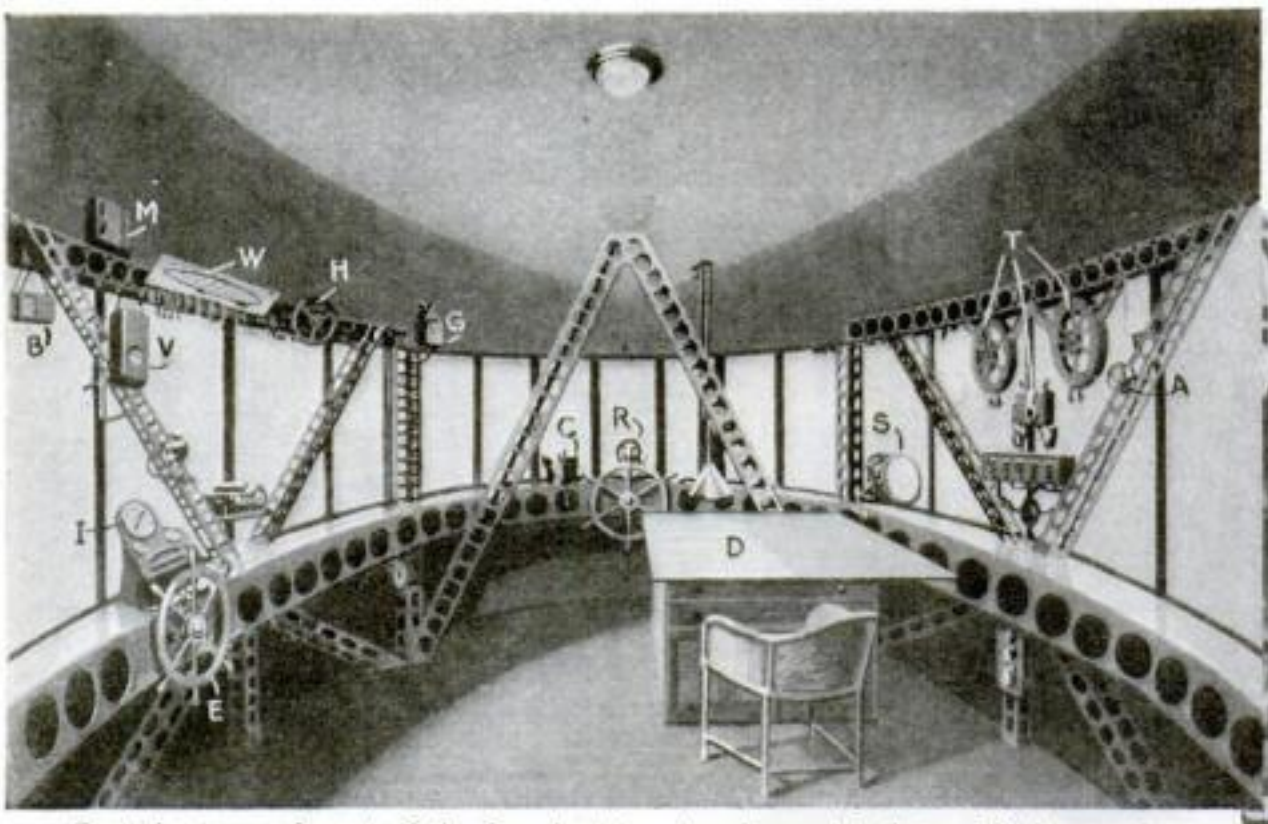
Drawn especially for POPULAR SCIENCE MONTHLY *by B. G. Seielstad*

FROM wood pulp to artificial silk—a pictorial story of progressive steps in the so-called viscose process of manufacturing rayon. Eighty-five percent of the world's rayon now is made by this method, which was perfected in 1900 by two British chemists. The raw material from which are spun the fine silky threads is cellulose extracted either from the pulp of spruce wood or from cotton linters—the coarse, left-over cotton fibers formerly discarded as waste. Ground into crumbs and treated first with carbon bisulphide and then with caustic soda, the cellulose is converted into a viscous or sticky solution which, when it solidifies, can be drawn into slender filaments by a spinneret. The filaments then are spun into thread.

Flying with an Airship Captain

The Veteran Commander of Navy Dirigibles Tells of His Experiences in Piloting the Los Angeles

By Lieut. Commander
CHARLES E. ROSENDAHL



Control room equipment of the *Los Angeles*. A—air speed indicator; B—barograph; C—magnetic compass; D—chart desk; E—elevator wheel; G—gas thermometer; H—helium gas release toggles and master valve wheel; I—inclinometer, aneroid barometer, and stop watch; M—mooring force indicator; R—rudder wheel; S—searchlight; T—engine room telegraphs, telephone; V—height change indicator; W—water ballast chart and release.

Chief Engineer's assistant at his post at the engine telegraph control of the *Los Angeles*.

WE WERE just back from Panama, one March night, and the *Los Angeles* was being hauled down to the ground in its second landing attempt. The men on the ropes and those holding the handrails on the outside of the cabins were walking the ship across the field to the hangar. Down the field a cloud of snow arose—a squall was approaching. It hit. The great ship swayed in the gust. Dragging the ground crew with her, she was swept toward the trees that border the field.

"Let go all lines!" Overboard went water ballast. The ship leaped into the air. Five or six of the ground crew had not been quick enough to let go. Then they were afraid to jump. They were carried up, clinging like flies to the outside of the cabin, their legs dangling in mid-air. Five hundred feet from the earth, they were pulled in through the cabin windows. Cruising about until the squall had passed, perhaps an hour later, the ship landed safely and was docked in the hangar.

That night provided the closest shaves the *Los Angeles* ever had. Only an hour or so before, in an attempt to tie to the mooring mast, rough winds had jerked the ship about so violently that a nine-sixteenth-inch mooring cable snapped just in time to save the framework of the ship from damage.

Operating airships has provided many an exciting experience. Once the *Los Angeles* narrowly avoided collision with an airplane at night. Another time she was shot at, in the air, by an over-enthusiastic New Jersey duck hunter. Torn fins have been patched high in the air, and our ships have flown through lightning storms.

The high spots of a flight for an airship captain are its start and its finish. Launching an airship requires extreme care. The crew—say eight officers and thirty enlisted men—are at their stations in the ship, while the ground crew walks it out of the hangar. The captain walks out beside the mooring officer, who, from the ground, will direct the maneuver. The most critical part is getting the ship past the hangar door. At that moment a sideward gust on the huge bag might sweep it with thousands of pounds' force out of the ground crew's hands and against the wall. The take-off is purposely delayed until such danger is minimized, and when the ship is safely on the field the captain steps into the control cabin.

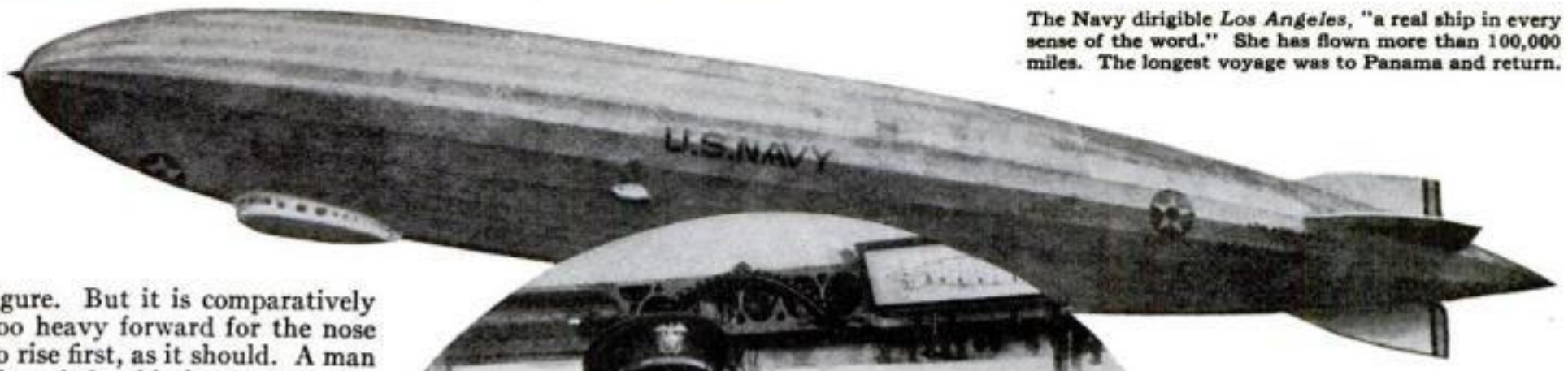
A green flag, or at night a green lantern, in the hands of an orderly makes it easy to see where the mooring officer is. "Give us a weigh-off!" is called out to him. The buoyancy of the ship has already been adjusted roughly in the hangar, and this is the final weighing before we ascend.

"Stand by to weigh off!" commands the mooring officer. The order passes from mouth to mouth down the length of the 656-foot ship. The ground crew sets the control car and the after gondola down on the ground, holding them by the handrails along the sides. At a distance from the ship are the men on the handling lines.

"Hands off!" They allow the ship to rise to arm's height, then at "Hold!" they bring it back, estimating the buoyancy, if it tends to lift, by the weight of the men required to hold it down. The reports come in: "Four hundred pounds light, aft." "Three hundred pounds light, forward."

That means that each end can lift that many pounds; in this case the total buoyancy of the ship is 700 pounds, a good

SQUADRON Commander of the United States Navy's airship fleet at Lakehurst, N. J., Commander Rosendahl is America's foremost authority on dirigible navigation. Until May of last year he captained the *Los Angeles*, and previously was second in command of the ill-fated *Shenandoah*. Here he recalls some of his exciting experiences, and describes the interesting technique of handling a 656-foot air liner.



The Navy dirigible *Los Angeles*, "a real ship in every sense of the word." She has flown more than 100,000 miles. The longest voyage was to Panama and return.

figure. But it is comparatively too heavy forward for the nose to rise first, as it should. A man aboard the ship is sent from the forward end aft. The trim is now satisfactory.

"STAND by for 'Up ship!'" Ropes are cast off. In the control cabin the Engineer Officer pulls over the indicator of the engine telegraph to "Two engines ahead, half speed." A gong clangs in the motor gondolas. Compressed-air starters spin the motors. They fire. A stream of air shoots back past the elevators or "flippers" that the elevator man is ready to raise, to force up the nose of the ship as soon as it is clear of the ground. The ground crew is tugging at the handrails along the cars to hold back the throbbing ship.

"Up ship!" The ground crew literally throws the ship high in the air. We go up nose first. "All engines ahead, cruising!" signal the engine telegraphs. We're off!

Almost every week, on the average, the *Los Angeles* takes the air on training flights, cruising within a 500-mile radius of the Lakehurst Naval Air Station. Longer trips are made for special purposes, such as the recent flight to participate in the air meet at Cleveland, Ohio. Since we demonstrated hooking on an airplane in flight at that meet, by the way, we have repeated the stunt successfully nearly every time the ship goes out, and it is getting to be a routine matter.

Our longest flight was the trip to Panama and back, more than 2,000 miles each way. We have landed the ship, at sea, at the mast of the tender *Patoka* and on the deck of the airplane carrier *Saratoga*. Two years ago we searched the North Atlantic for signs of the missing Grayson transatlantic plane. We spent all of one summer calibrating radio beacon stations along the Atlantic coast from Boston down past Hatteras, operating part of the time from the tender *Patoka* as a base. Other jobs have been numerous, and in all the *Los Angeles* has flown well over 100,000 miles.

Once in the air, the ship ascends under power by pointing the nose upward, but can climb also by dropping water ballast. She comes down either by flying down or by valving off helium gas. Toggles in rows, small handles shaped like telephone receivers, line the side of the control cabin and govern the release of ballast and of gas. By pulling one of the handles and counting seconds, we estimate just how many pounds of water have been dropped from one of the ballast bags, or by how many pounds the lifting force of one of the gas cells has been decreased.

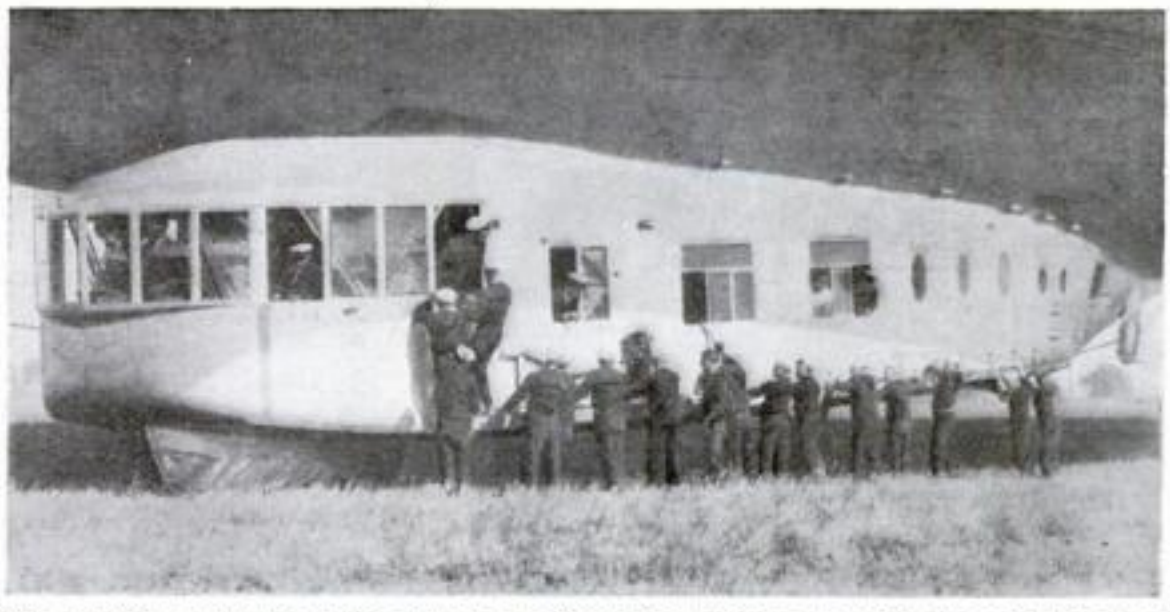
A steersman at the elevator wheel, on the left of the control cabin, guides the ship up or down; another at the forward end steers it to port or starboard. On board an airship, we use nautical language, for we regard the *Los Angeles* as a real ship in every sense of the word. A day's run is even spoken of as the number of "miles steamed," ignoring the fact that the ship runs on gasoline.

Lieut. Commander Charles E. Rosendahl, standing beside the elevator wheel of the *Los Angeles*, which he commanded for three years.

A great airship has a sort of personality all its own. An experienced dirigible commander could identify the *Los Angeles*, the *Graf Zeppelin*, or the *Shenandoah* partly by the way each answers its controls. The shape of the airship makes considerable difference, as do the size and location of the fins. The *Los Angeles* responds quickly to outside air disturbances and also to her own controls, partly because her streamlined body is thick in proportion to her length—giving her what we call a "low fineness ratio."

Moreover, the comparatively shorter and fatter type of construction, followed also in designs for future dirigibles, makes an inherently stronger ship than the *Shenandoah*, which had a long, slim hull. That slenderness, I think, was the main reason why the *Shenandoah*, bound for the midwest four years ago, was wrecked when it ran into a line squall near Ava, Ohio. Caught between sharp and conflicting vertical air currents—the most dangerous thing that can happen to any aircraft in the air—her structure broke from unusual aerodynamic forces too great for it. Several of us, just above the control cabin when the crash came, heard a metallic noise of wrenching girders—and, in the gloom of daybreak, saw the after portion of the ship free itself and fall. Below, through the gap in the structure where the forward car had torn away, we saw the ground disappearing rapidly. Shouts disclosed that there were eight men in the rising section. With each man detailed to a station and a duty, we free-ballooned our section of the ship for more than an hour and then descended safely. Many of the men in the other part of the ship, we found, had escaped when it crashed. Of the forty-three men originally aboard,

(*Continued on page 158*)



The ground crew holding the control car of the *Los Angeles* to earth by handrails along the side. Once, in a sudden squall, some of the crew were carried, dangling, 500 feet high.

DR. C. G. ABBOT
Secretary, The Smithsonian Institution

DR. SAMUEL A. BROWN
Dean, N. Y. University and Bellevue Medical College

DR. GEORGE K. BURGESS
Director, The United States Bureau of Standards

DR. WM. W. CAMPBELL
President, University of California

DR. HARVEY N. DAVIS
President, Stevens Institute of Technology

DR. ARTHUR D. LITTLE
President, Arthur D. Little, Inc., Chemists

DR. JOHN C. MERRIAM
President, Carnegie Institution of Washington

DR. ROBERT A. MILLIKAN
Chairman, Executive Council, California Institute of Technology

The Men Who Will Award Our $10,000 Prize

TWENTY-TWO of America's foremost scientists and inventors have consented to serve as members of the Committee of Award which will administer POPULAR SCIENCE MONTHLY's annual award of $10,000 for the year's outstanding achievement in science, the creation of which was announced in the February issue. It will be the task of these men to review the year's activities in American science and invention and to select the accomplishment which, in their judgment, possesses the greatest potentialities as a contribution to the welfare of mankind. The names of many of the Committee are household words in the United States and abroad; others are better known to the world of science than to the general public; all of them are undisputed leaders in their respective fields. In the following series of brief sketches, POPULAR SCIENCE MONTHLY introduces the distinguished members of the Committee to its readers.

DR. CHARLES GREELEY ABBOT is secretary of the Smithsonian Institution, at Washington, D. C., and director of its Astrophysical Observatory and stations in Chile, California, and South Africa. In these observatories exact measurements of the sun's radiation are being made to discover the possible relation between sun spots and the weather, and to determine whether there are recurring cycles of weather. Eventually, experts believe, these observations and others which Dr. Abbot and his staff conducted in the last year at Mt. Wilson Observatory in California may lead to the practicability of forecasting the weather a year or more in advance. Dr. Abbot is also responsible for brilliant work in establishing how much of the sun's heat and light are absorbed by the atmosphere before they reach the earth's surface and in measuring the energy of stars.

DR. SAMUEL ALBURTUS BROWN, distinguished as a physician and surgeon, has been dean of the New York University and Bellevue Hospital Medical College for fifteen years, after serving as a member of the faculty of the institution since 1896. His particular interest has been in connection with the diseases of heart and lungs. He also serves as attending and consulting physician in a number of large hospitals. From 1900 until 1910, he was assistant surgeon in the Twelfth Regiment, New York National Guard, and holds the rank of Lieutenant Colonel in the United States Army Reserve. He is past president of the New York Academy of Medicine, a member of the American Medical Association, the Medical Society of the State of New York, and the New York County Medical Society.

DR. GEORGE KIMBALL BURGESS has been director of the United States Bureau of Standards, at Washington, D. C., since 1923. Before that he was in charge of the Division of Metallurgy. Dr. Burgess has done outstanding work in developing systems of measurement of very high temperatures. In metallurgical research, his efforts have been concerned among other things with the development of lightweight alloys for aircraft construction and methods of testing their strength and other properties. He is the author of standard works and textbooks on the subjects of the constant of gravitation and experimental physics, and co-author of a book on the measurement of high temperatures. He is the treasurer of the National Academy of Sciences and a member of the foreign service and engineering committees, National Research Council.

DR. WILLIAM WALLACE CAMPBELL is head of the Lick Observatory, Mt. Hamilton, Calif., and president of the University of California. He has done invaluable work in investigating the orbits of comets, their spectra, stars, and nebulae, the motions of stars, and solar eclipses. He has been Silliman lecturer at Yale, William Ellery Hale lecturer of the National Academy of Sciences, and Halley lecturer at Oxford University, England.

PROF. HENRY F. OSBORN
President, The American Museum of Natural History

DR. ELMER A. SPERRY
Chairman, Board of Directors, Sperry Gyroscope Co.

DR. S. W. STRATTON
President, Massachusetts Institute of Technology

DR. ARTHUR L. DAY
Director, Geophysical Laboratory, Carnegie Institution

DR. E. E. FREE
Consulting Engineer

DR. FRANK B. JEWETT
Vice-President, American Telephone and Telegraph Co.

DR. VERNON KELLOGG
Permanent Secretary, National Research Council

CHARLES F. KETTERING
President, General Motors Research Corp.

In recognition of his services to astronomy, an unusual number of awards, distinctions, and foreign orders have been bestowed upon him. Among Dr. Campbell's books are *The Elements of Practical Astronomy*, *The Return of Halley's Comet*, and *Stellar Motions*. He is a member of the National Academy of Sciences.

DR. HARVEY NATHANIEL DAVIS, president of Stevens Institute of Technology, at Hoboken, N. J., is a recognized expert on such varied subjects as turbine engineering, aeronautical structural design, mining engineering, and the preparation of commercial gases. Dr. Davis has served the United States Government as an aeronautical mechanical engineer in the Air Service and as consulting engineer of the Bureau of Mines. He has also been connected, as engineer and consulting engineer, with the General Electric Company and other concerns. He is a graduate and former member of the faculty of Harvard University. Dr. Davis is co-author of one of the most widely used textbooks of practical physics.

DR. ARTHUR LOUIS DAY has been director of the Geophysical Laboratory of the Carnegie Institution, at Washington, D. C., for twenty-three years. An authority on such widely divergent subjects as the chemical and physical problems of volcanoes and the production of optical glass, he also is known for his research work in the field of physical phenomena at very high and very low temperatures, the exact measurement of high temperatures, and thermal studies of rock-forming minerals. Dr. Day was formerly physical geologist with the United States Geological Survey, a member of the scientific staff of the physio-technical government laboratories in Charlottenburg, Germany, and instructor in physics at Yale University. He is past president of the Washington Academy of Sciences, former home secretary of the National Academy of Sciences, a Fellow of the American Academy of Arts and Sciences, and a member of several other societies.

DR. EDWARD ELWAY FREE, widely known as a writer on scientific subjects, also practices as a consulting engineer and is special lecturer in charge of courses in general science at New York University. During the World War, he served as an officer in the Ordnance Department and Chemical Warfare Service. He has been the editor of scientific journals, and now serves several publications as scientific adviser. Dr. Free holds the degree of Doctor of Philosophy from Johns Hopkins University and was research associate of Carnegie Institution and Massachusetts Institute of Technology. He is past president of the New York Electrical Society and a member of a number of other engineering and learned societies.

DR. FRANK BALDWIN JEWETT, vice president of the American Telephone and Telegraph Co. and president of the Bell Telephone Laboratories in New York City, has contributed in large measure to the tremendous advance in telephone communication during the last twenty-five years through a succession of inventions and applications of science to electrical communication produced and developed by the laboratories under his direction and often with his personal participation. Recipient of the degree of Doctor of Philosophy from Chicago University, Dr. Jewett also holds the honorary degree of Doctor of Science from five great universities and that of Doctor of Engineering from a sixth. He is past president of the American Institute of Electrical Engineering, which bestowed its Edison Medal upon him for his contributions to electrical science. The United States Government has honored him with the Distinguished Service Medal, and the Mikado of Japan with the Order of the Rising Sun.

DR. VERNON LYMAN KELLOGG, one of America's foremost zoologists and entomologists, permanent secretary of the National Research Council, Washington, D. C., and chairman of its Division of Educational Relations, is equally noted as a philanthropist, humanitarian, educator, and author. During the World War, Dr. Kellogg was assistant to President Hoover, then United States Food Administrator, and later was director in Brussels of the American Commission for Relief in Belgium. He also served with the American Relief Administration in Poland, Russia, and other European countries. Dr. Kellogg has published nearly a score of works and textbooks on biological, zoological, and entomological subjects, and is also the author of books of a more general nature, among them a biography of Herbert Hoover, studies of the effects of war upon the human race, and other works.

CHARLES FRANKLIN KETTERING. The inventor of the self-starter, the Delco ignition and lighting systems, and Ethyl gas, Mr. Kettering, president and general director, Research Laboratories, General Motors Corporation is *(Continued on page 141)*

DR. ELIHU THOMSON
Director, General Electric Research Laboratories (Lynn, Mass.)

DR. E. R. WEIDLEIN
Director, Mellon Institute of Industrial Research

H. H. WESTINGHOUSE
Director, Westinghouse Electric & Manufacturing Co.

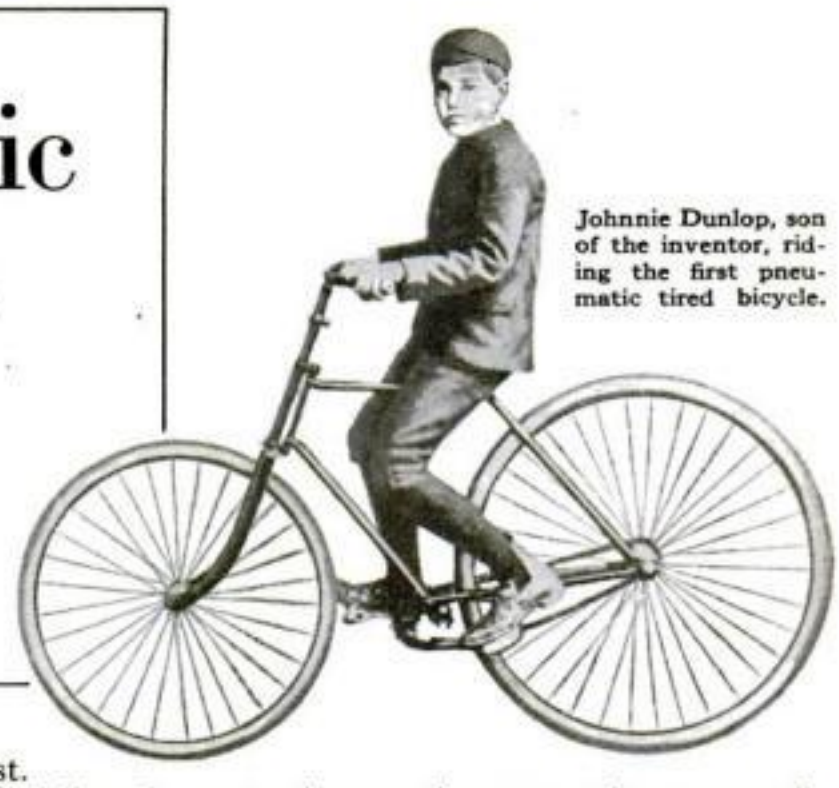
ORVILLE WRIGHT
Scientist and Inventor

DR. WILLIS R. WHITNEY
Director of Research, General Electric Co. (Schenectady, N. Y.)

DR. ALBERT E. WHITE
Director, Dept. of Engineering Research, U. of Michigan

The First Pneumatic Tire—Invented to Please a Boy

By H. C. DAVIS



Johnnie Dunlop, son of the inventor, riding the first pneumatic tired bicycle.

IF ALL the rubber consumed in the United States last year in the manufacture of tires were made into a single tire of average automobile tread, it would have a diameter of more than forty miles. Lying on the ground, it would encircle 1,400 square miles of territory, far more than is contained in the state of Rhode Island. Upright, it would tower above the clouds, approximately eight times as high as Mount Everest, the world's tallest peak.

Yet, forty-two years ago, there was but one pair of pneumatic tires in existence. They were on the rear wheels of a tricycle which a small boy, Johnnie Dunlop, rode through the outskirts of Dublin, Ireland, one moonlight night in February, 1888, for an initial test. His father, an inventive veterinary surgeon, had fitted a pair of bulging, air-filled tubes to the wheels in place of the hard rubber strips common in those days, to give Johnnie a faster machine to beat a bigger boy who had defeated him in after-school tricycle races in the People's Park. It was ten o'clock at night when the work on the new wheel was finished. Unable to wait until morning, young Johnnie Dunlop set out for a speed trial. About eleven o'clock, an eclipse of the moon occurred and he rode home in the dark.

In this manner, the first pneumatic tires in history received their road test.

In the four decades that have followed, approximately 750,000,000 have been made to cushion the bumps of road travel in all parts of the world. In 1929 nearly eighty-five percent of the rubber consumed in the United States went into the making of tires. So vital has rubber become to present-day civilization that Thomas A. Edison, at the age of eighty-two, is concentrating upon the problem of obtaining a new source of supply from goldenrod and other native weeds. In tropical countries, seven million acres are devoted to rubber trees in an effort to supply the demand which the pneumatic tire has largely created.

John Boyd Dunlop, inventor of pneumatic tires, as he appeared shortly before his death in 1921.

Applying the curing rings—one of many steps in modern tire manufacture.

Although the birthplace of the pneumatic tire was Ireland, its inventor was not Irish. John Boyd Dunlop was born in a tiny village in Ayrshire, Scotland. At nineteen, he graduated with a degree of veterinary surgeon from Edinburgh. A few years later, he emigrated with his diploma to Dublin and built up an extensive practice, concocting new medicines and devising original surgical equipment to relieve animal suffering. Always of an inventive turn of mind, he spent his leisure for nearly twenty years puzzling over methods of reducing the jolts and vibrations of road travel. As he bumped along in his buggy, making country calls, he planned various forms of spring wheels. Discouraging failures resulted. With characteristic determination, he stuck to his hobby. While using sheet rubber in his surgical work, the idea of air-filled tubes occurred to him. The legend that he used a garden hose for a tire seems to be without foundation.

AS A first experiment, Dunlop made a disk of wood. It was sixteen inches in diameter, the same size as the front wheel of the tricycle which his son, Johnnie, rode. To the rim he attached a rubber tube by means of a canvas cover which was tacked to the wood. Taking the disk with its air-filled tire, and the tricycle wheel with its hard rubber one, into the yard, Dunlop asked an assistant which would roll farther. "The one with the hard tire, of course," was the answer. To the assistant's surprise, the disk with the big, air-filled tire rolled twice as far, struck a gate, and bounded back several feet.

When Johnnie saw this result he immediately wanted new and faster tires for his tricycle. Working evenings, after the day's round of treating sick cows and ailing horses, his father made two wheels, forming the rims of American elm and fastening the "D"-shaped tires to them by cementing the last of the layers of rubber and canvas around the rims. The "nonreturn" valve of the tire was formed by a strip of rubber, placed over the lower end of the supply tube and glued at both ends. When air was pumped in, it forced the middle of the rubber strip inward, allowing the air to enter. When pumping stopped, the air inside forced the rubber strip back over the opening, closing it.

The tires were inflated with a football pump and Johnnie set out upon his famous moonlight ride. The next day, his tricycle set a pace that left his rivals far behind.

Speed was an important item then. Tricycle and bicycle racing was in vogue. The first motor car had been built only four years before. (*Continued on page 166*)

PROGRESS AND DISCOVERY

Developments in engineering, exploration, and discovery, and news of the world's progress in science are recorded on these pages. Here are included the interesting features previously presented in "Back of the Month's News."

Panning for Gold—The Old and New Ways

REMINDERS of the days of '49 may still be found today in the dogged prospectors who still haunt the streams of northern California panning for gold. They always hope that they will find the mother lode. The modern methods of prospecting are electrical. Apparatus is used which can detect an underground vein without the need for digging an ounce of earth (P.S.M., Feb. '29, p. 26). Gold dredges, some of them 200 feet long, and with huge arms spreading 400 feet, pan the precious metal in bulk.

In northern California the largest gold dredges in the world are operated. During twenty years of excavation more material has been turned over there than in the construction of the Panama Canal. The dredges plow through virgin soil down to solid rock. They can dig eighty-two feet below the water line. The stream bed is dredged up, passes through filters, and the gravel cleaned of the gold is thrown by the giant conveyor arm to the shore. Rock-crushing plants are installed in the wake of the dredges.

Above: Giant electric gold-panning dredge working a stream in northern California. Left: A prospector of the old school panning by hand.

Forestry Weather Bureau Travels by Truck

WEATHER forecasts from almost inaccessible regions will now be practical, it is said, by the use of a new traveling weather bureau recently sent to the Sierra Madre Mountains for the United States Forestry Service. The equipment, housed in a motor truck, consists of an elaborate radio receiving and transmitting equipment plus all the usual instruments necessary to measure wind velocity, humidity, and barometric pressure. It will meet the need of obtaining accurate information of weather conditions at points threatened by forest fires.

A California deputy fire warden tuning the radio set of the new traveling weather bureau.

Huge X-Ray Tubes Produce Man-Made Radium Rays

A BATTERY of giant X-ray tubes immersed in a tank of oil and operated at the electric pressure of 1,600,000 volts produced man-made rays like those of radium in a recent demonstration at Washington, D. C. The experiment, performed by the Carnegie Institution, was a step forward in attempts of physicists to break down the atom itself. If this can be done, it may be possible to "transmute" one element into another.

For this purpose the Carnegie Institution built a huge electric machine, consisting of a giant spark coil in an oil tank capable of generating electricity at 5,000,000 volts (P. S. M., Jan. '29, p. 23). Vacuum tubes capable of applying this tremendous voltage, however, remained to be constructed. The new arrangement of X-ray tubes promises a possible way of doing it. Immersing the tubes in oil and shielding one from another permits higher voltages. The rays feed from one tube to the next, an arrangement developed originally by Dr. W. D. Coolidge of the General Electric Company for hooking up cathode ray tubes.

Dynamite Blast Travels Four Miles a Second

WHEN a stick of dynamite goes off, the wave of explosion travels along the cartridge at four miles per second, one of the fastest chemical "reaction" speeds known. Experts at the laboratories of the United States Bureau of Mines at Bruceton, Pa., have been measuring this speed by a clever mechanism called the mettegang (German for "go-between") recorder. This measures the time elapsing between the rupture of two wires threaded through the dynamite stick by recording it on a rapidly whirling smoked drum.

Excess Humidity Reduces Auto Engine Power

A POPULAR impression among motorists has been that automobile engines run better in muggy weather. That the opposite is true is now revealed by recent tests on six-cylinder engines, announced Daniel P. Brooks of the Bureau of Standards of the United States Department of Commerce. They have shown that loss of power is directly proportional to the excess of moisture in the air. But strangely enough, this does not necessarily mean less power when it is raining, as it is quite possible to have less moisture in the air on a cool rainy day than on a hot, muggy one.

The loss of power is proportional to

the "absolute" humidity, which means the quantity of water vapor in the air at the time of observation. It is usual, however, to find that the loss of power on a muggy day is not especially noticeable, since excessive moisture may be counterbalanced by the effect of air temperature. Another factor which governs power is the atmospheric pressure which also balances one another that no variation in engine power is observable.

Tomatoes, Potatoes Grow on the Same Plant

The remarkable "tomapotato" plant, ten feet tall, overtops its creator, Oscar Soderholm.

THE "tomapotato," a new plant demanding a new name, which produces potatoes at its roots below the ground and tomatoes on its stalk above the earth, has been developed after twenty years of experiment by Oscar Soderholm, foreman of a florist's greenhouses at Worcester, Mass. The plant is no freak, but is the demonstration of Soderholm's theory that, as the roots of the potato plant are stronger than those of the tomato, the combination should produce better tomatoes. His results have proved the soundness of the theory, he claims, for not only does his hybrid grow potatoes but the grafted tomato section attains a height of ten feet, if supported, and bears more fruit than a normal plant.

In grafting his queer plant, Soderholm starts by planting a piece of potato, containing at least two eyes, in the ground, and planting tomato seeds in a pot. When both have grown to vines about one quarter of an inch in diameter, he makes a cut diagonally across each; then he matches them and ties the grafting together with a thread. Special care must be taken to prevent wilting.

Soderholm now plans experiments in grafting cucumbers on Hubbard squash, the roots of the squash being much the stronger of the two.

New Gas Treatment Ripens Fruit in a Few Hours

THROUGH a process developed in the research laboratory of the United States Department of Agriculture, fruit that would take many days or weeks to ripen on the trees may be ripened in storage in only a few hours by treating it with ethylene gas. The treatment may also be used, it is said, to color the fruit and to add to its sweetness.

The photograph above shows W. G. Sorber, junior chemist in the laboratory, examining a tray of pears being gassed.

Though brightness in color is no gage of the flavor of fruit, most people seem to prefer more brilliant-toned oranges, for example, to the lighter hued and often tastier variety. With the ethylene treatment, fruit may have its color deepened to satisfy the demand for brightness.

Moreover, fruit crops may be better controlled. Instead of a crop's being put on the market all at once, it may be gathered in instalments, and each instalment ripened quickly through the artificial process while the remainder continues its slower process of natural ripening on the tree.

Largest of Submarines Launched in France

THE world's largest submarine has been launched at Cherbourg, France. The *Surcouf*, 400 feet of steel naval defense, has complete armor protection for all vital parts exposed when running at the surface. This makes her really an armored cruiser, as she can withstand the shells of light quick-firing guns and can return fire. Her displacement is 3,257 tons at the surface and 4,330 tons when submerged. The biggest submarine in the war, the *U-139*, had a surface displacement of 1,930 tons, and 3,050 tons when submerged.

The *Surcouf* can make twenty-five miles per hour, five miles faster than the *Humayta*, recently built in Italy for Brazil. She will carry four 5.5-inch guns, fourteen tubes which can be used all at the same time, and will have a small seaplane stored on board. Officers and crew will number 150.

The heavy armament of the new battle whale will enable her to sink to a depth of 430 feet, 100 feet deeper than any previous submarine. She will have a fuel capacity to take her 13,000 miles, or halfway round the world, without a stop.

Predicts Earth May Grow Rings Like Saturn's

SOME day the earth may have rings like Saturn's. This possibility was suggested recently by Dr. Harlow Shapley, director of the Harvard College Observatory.

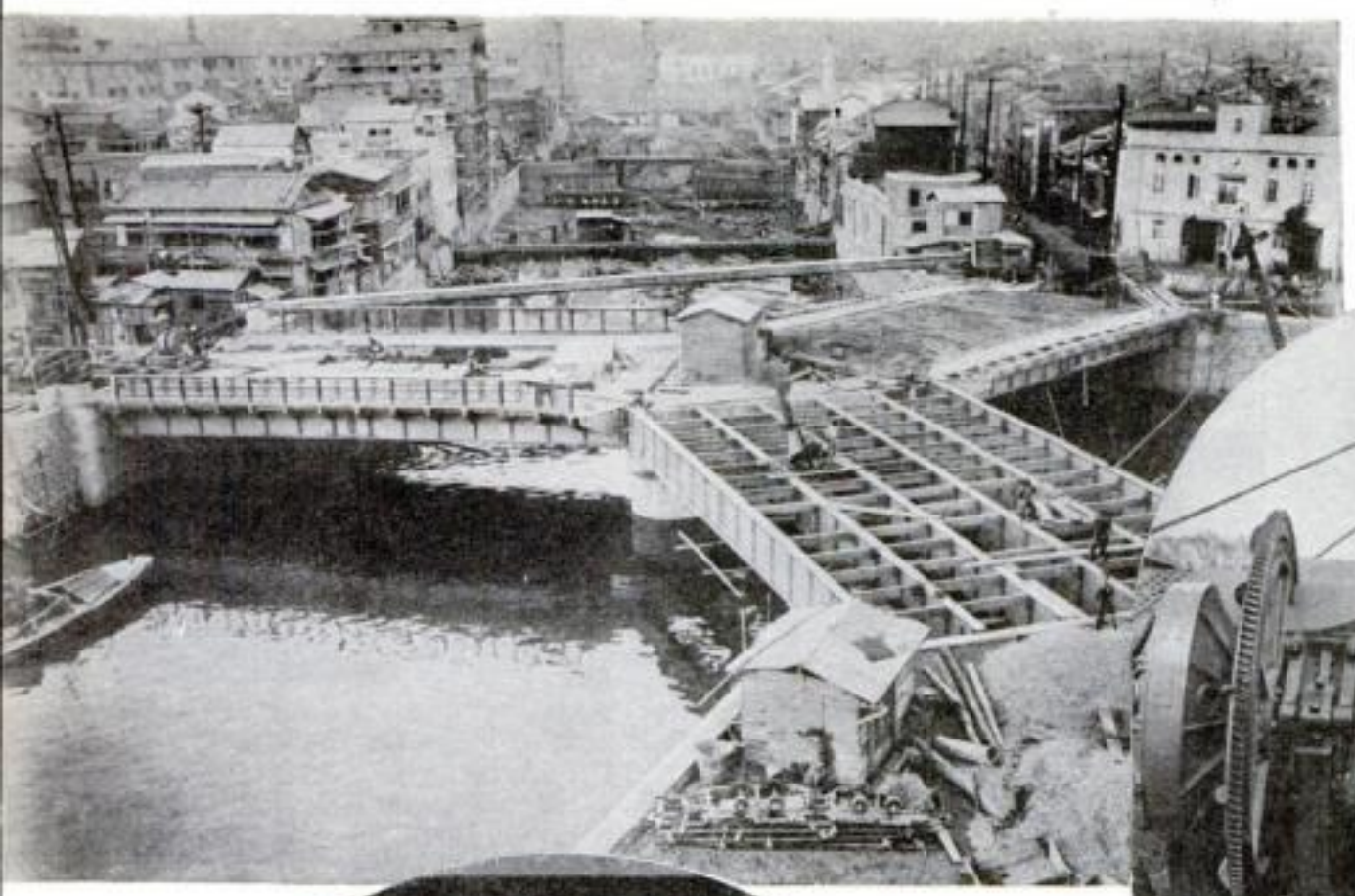
Saturn's rings are held to be composed of myriads of tiny moons. The earth's rings, according to Dr. Shapley, would be formed from fragments of the earth's moon. It is known to be approaching the earth, because of the gradual slowing down of the solar system. At a short distance, this expert predicts, the earth's tidal forces will break it up. According to Dr. Shapley's figures, this may happen about A. D. 50,000,000,000.

Silencer Reduces Noise of Street Drills

A PARTIALLY noiseless pneumatic drill for tearing up city streets and similar excavation work has been tested in London and found to be successful. It is said to reduce the noise of drilling by more than sixty percent.

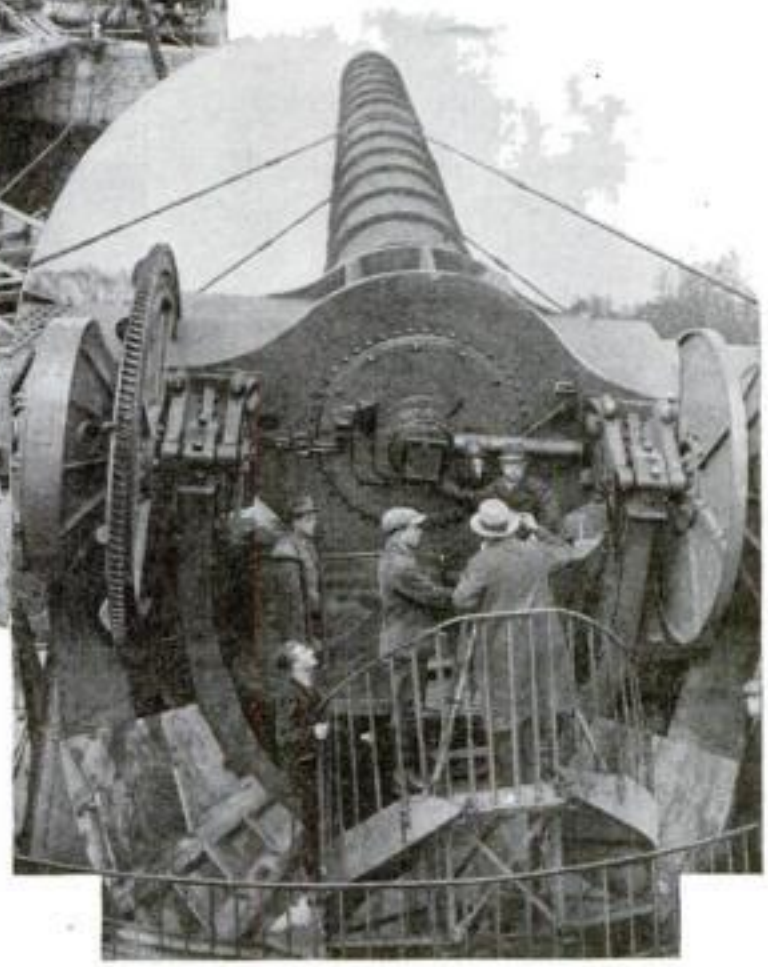
Two methods of noise prevention are used. One is the principle of the silencer, by which the noise of the exhaust air let out of the drill's air chamber at the end of each stroke is partly prevented, as is done by the silencer on a gun or the muffler on an automobile engine. The second is a redesign of the valves controlling the motion of the compressed air through the apparatus, so that these valves move through much shorter distances and make less noise when they strike the walls of the cylinder.

Equipped with silencer, this pneumatic road drill is said to reduce noise sixty percent.

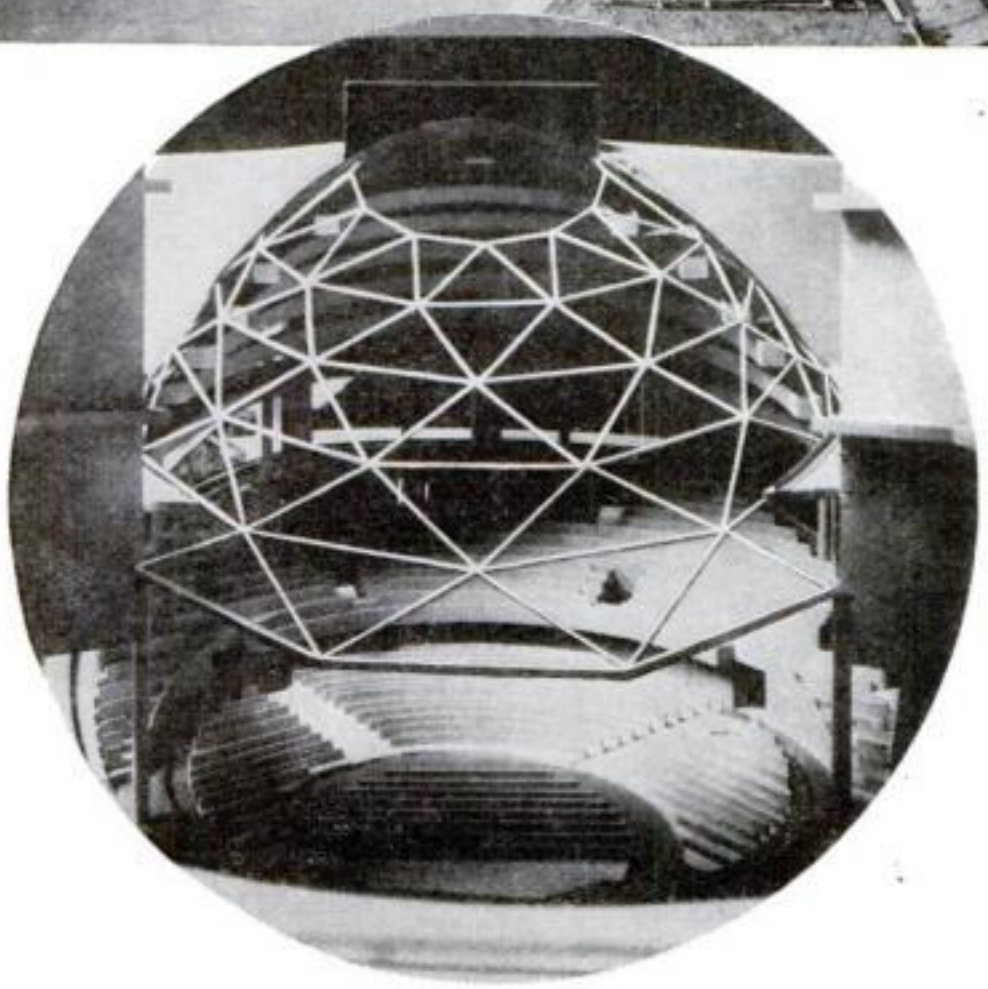


Japan's Three-Way Bridge

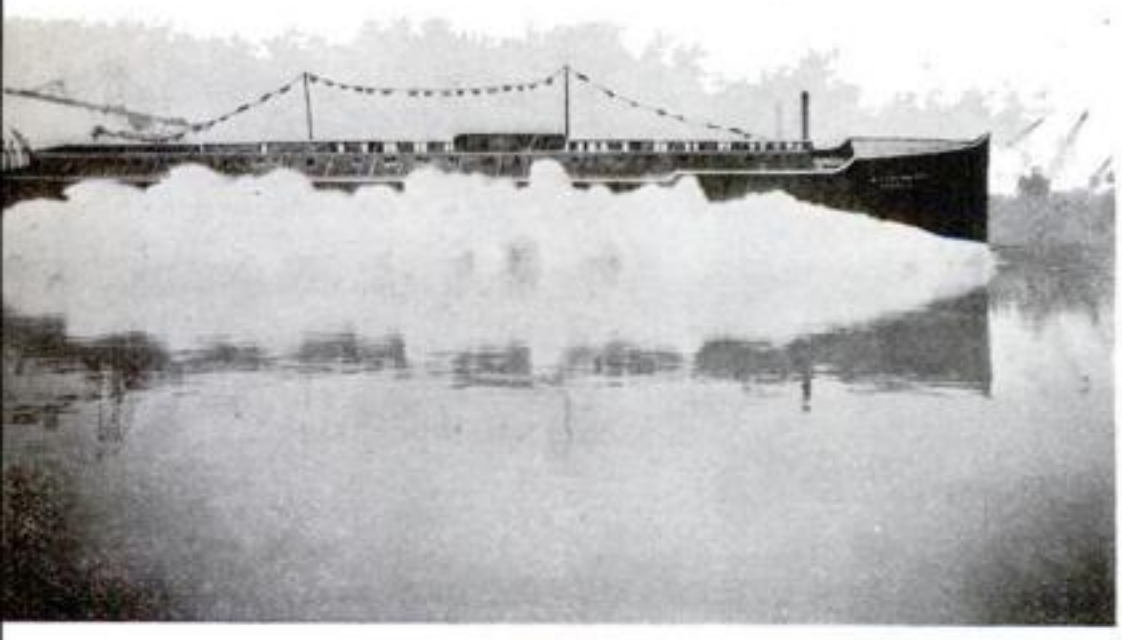
The unusual triple-span bridge pictured under construction at the left is an attempt of Japanese engineers to relieve traffic congestion across a junction of waterways at Kyobashi, the industrial center of Tokio.



A "Big Bertha" of Astronomy. Pointing like a mid-war Krupp gun at the glowing heavens, this new telescope is being used by astronomers at the Observatory of Treptow, Germany, for observation of the sun.



"Theater of the Future." That theater auditoriums soon will be patterned after ancient Greek amphitheaters is the prediction of a German architect, who has embodied his ideas in the model shown above. The domed roof has been skeletonized to show the interior.



Umbrellas Sold by Slot Machine

If caught in the rain, Berlin pedestrians now can deposit the equivalent of fifteen cents in a vending machine and pull out an umbrella. The folding emergency umbrella comprises a hood of oiled paper and a handle of wood.

First Electric Car Ferry

The photo at the left shows the launching of the *Saginaw 31*, first of a fleet of turbo-electric driven car ferryboats for Great Lakes traffic. Each can carry thirty eighty-ton railway freight cars.

PROGRESS AND DISCOVERY

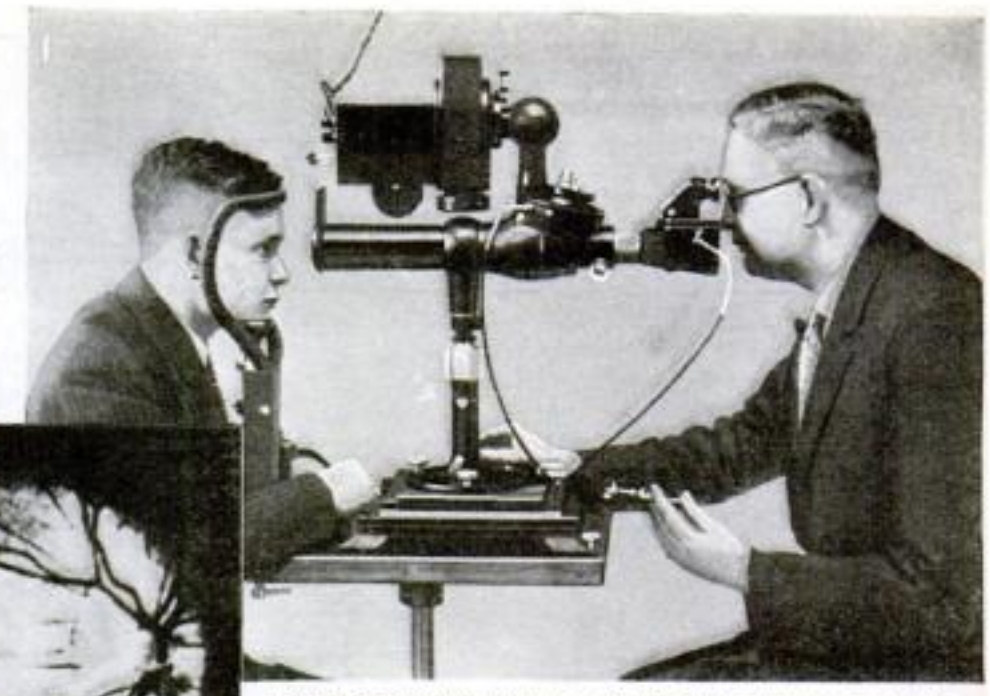
New Camera Photographs Eyes to Find Secrets of Vision

SECRETS of vision that lie within the retina of the human eye on which, day after day, millions of pictures are photographed successively, are now being investigated by means of a new camera perfected at the famous Zeiss optical works at Jena, Germany.

The new Nordenson camera, sliding up and down on its stem, may be adjusted to any height necessary to focus the eyeballs of the subject to be photographed. The subject sits in a chair at one side of a stand on which the apparatus rests, with his chin resting on a padded support from which an arm rises to encircle his face, thus insuring immobility and a standard position for taking the photograph.

At the other side of the camera, the operator looks through an eyepiece and manipulates the adjusting screws of the camera until the retina to be taken is in perfect focus. The subject stares into a tubular hood at the front of the camera and while his eye is functioning normally, the photograph is made with an exposure of only one twentieth of a second.

Below is a remarkable photograph of the retina of a human eye made with the new camera at the right. The dark lines are arteries.



Focusing the eye camera. As the subject stares into the camera, his head is kept stationary by special braces.

Foresees Electric Heat from "Coke Batteries"

GIANT electric batteries, consuming coke and air and yielding electricity cheaply enough to revolutionize house heating and other branches of practical engineering, are suggested as possibilities by Professor M. deKay Thompson of the Massachusetts Institute of Technology.

To heat a house or to generate electricity at present, Professor Thompson says, coal, coke, or some other fuel must be burned in a furnace or under a steam boiler. This is always a wasteful process. Theoretically, he points out, the carbon of the coke might combine directly with the oxygen of the air in a special electric battery, yielding electricity, just as happens when metallic zinc and the solution of chemicals combine in the ordinary dry battery. Such a coke battery might be so efficient as to utilize nearly all the energy of the coke instead of the fourth or less of it that is turned into electricity by ordinary methods.

Coke batteries have been constructed, Professor Thompson states, but they work too slowly for practical use. Some possibilities exist, he suggests, of escaping this handicap if inventors can devise suitable solutions and equipment.

Evidence of Nerve System Found in Plants

PERHAPS plants have nervous systems and hereafter may be treated by neurologists. In experiments with the large cells of the water plant Nitella, Dr. W. J. V. Osterhout, of the Rockefeller Institute, has found evidence of nerve currents similar to those of animal muscle and nerve. His experiments were conducted with the aid of an ingenious electrical apparatus which was able to detect minute electrical variations within the cells of the plant.

Discovery of "Flu" Germ Awaits Confirmation

A GERM that looks under the microscope like a string of pearls is probably the thing that gives people the "flu," according to Dr. Isadore S. Falk, University of Chicago bacteriologist. He reports that he has isolated the long-sought cause of influenza, and that experiments are already under way to develop vaccines and antitoxins to prevent and cure the disease.

The germs, to which only the laboratory name of "42X" has thus far been given, colonize in clumps. Some of them are rough, some smooth. The rough type is the more virulent, Dr. Falk believes; the smooth ones may be responsible for common colds and sore throats.

Announcement of Dr. Falk's discovery follows a year of work, in which he and thirteen assistants were stricken with influenza. A young woman among these furnished the germs that were finally isolated as responsible for the disease, after about 3,800 other kinds of microbes had been classed as "suspects." Experiments upon monkeys have given hope of immunizing against influenza, and tests upon human beings are scheduled.

Meanwhile, caution in accepting the results is advised by the American Medical Association, pending confirmation by others in the same field. This is at least the tenth time in five years, it points out, that discovery of the "flu" germ has been announced. Today specific treatment for influenza remains an indefinite future prospect. Such experiments as Dr. Falk's are always difficult to interpret, it says, although his work is "of great interest."

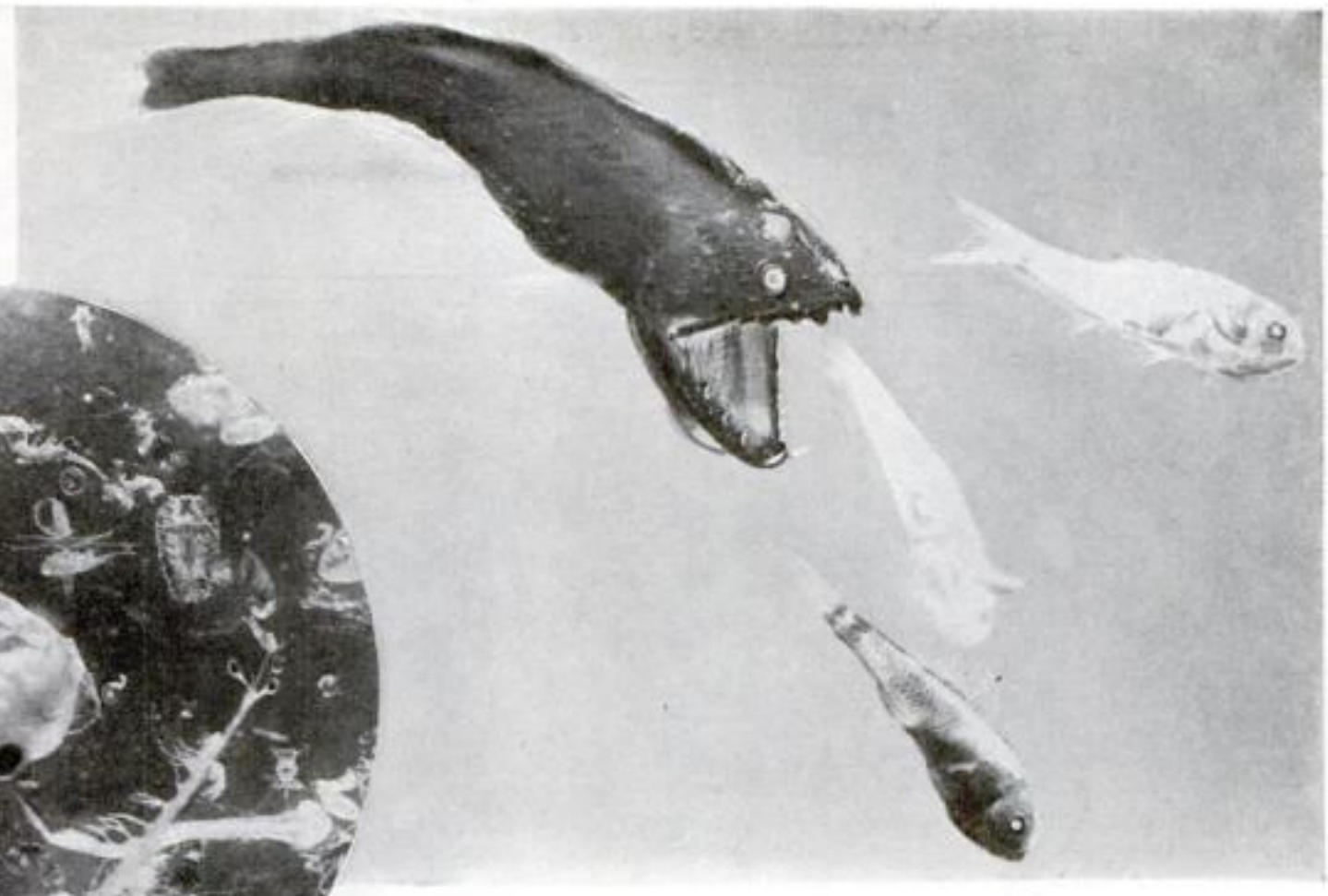
Dr. Isadore S. Falk, University of Chicago, who reports discovery of the influenza germ.

How Much Do You Know About Mechanics?

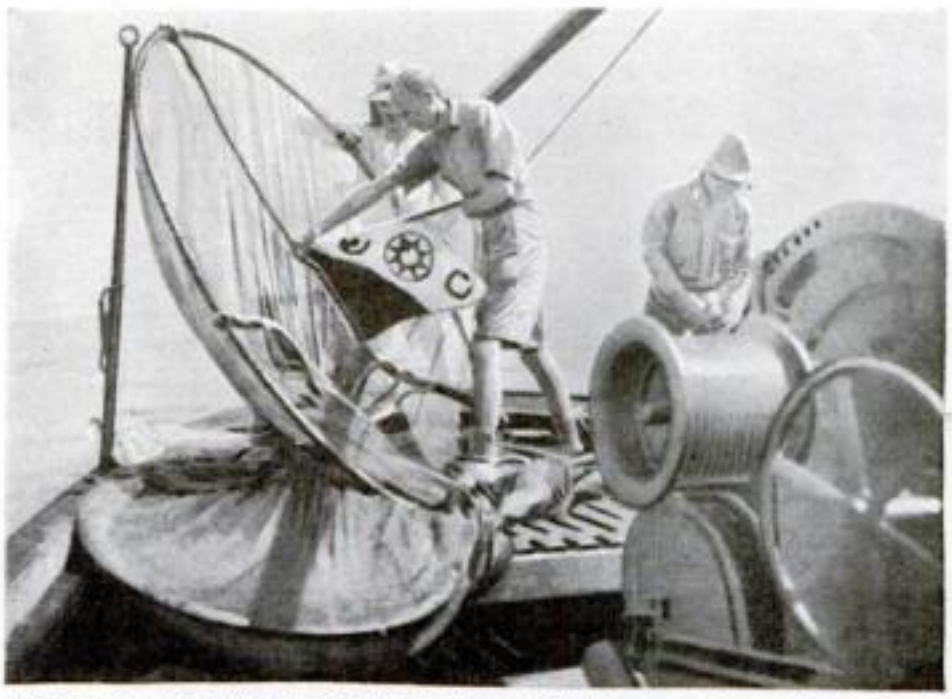
TEST your knowledge with these questions, chosen from hundreds asked by our readers. Answers appear on page 155.

1. **Why is it necessary to prime a pump?**
2. **Which is more powerful—an electric locomotive or a steam locomotive?**
3. **How would you compute the horsepower that can be developed by a waterfall?**
4. **How can two electric motors of different sizes develop the same power?**
5. **Why is a vacuum needed to run a steam engine?**
6. **How is it possible for a man to lift a heavy weight with a chain block?**
7. **What makes the draft up a chimney?**
8. **If you double the power in a motor boat will it go twice as fast?**
9. **What causes the hammering noise in a water pipe when you shut off the water suddenly?**

Another Rich Haul of Curious Fishes Found in the Ocean Depths off Bermuda by William Beebe

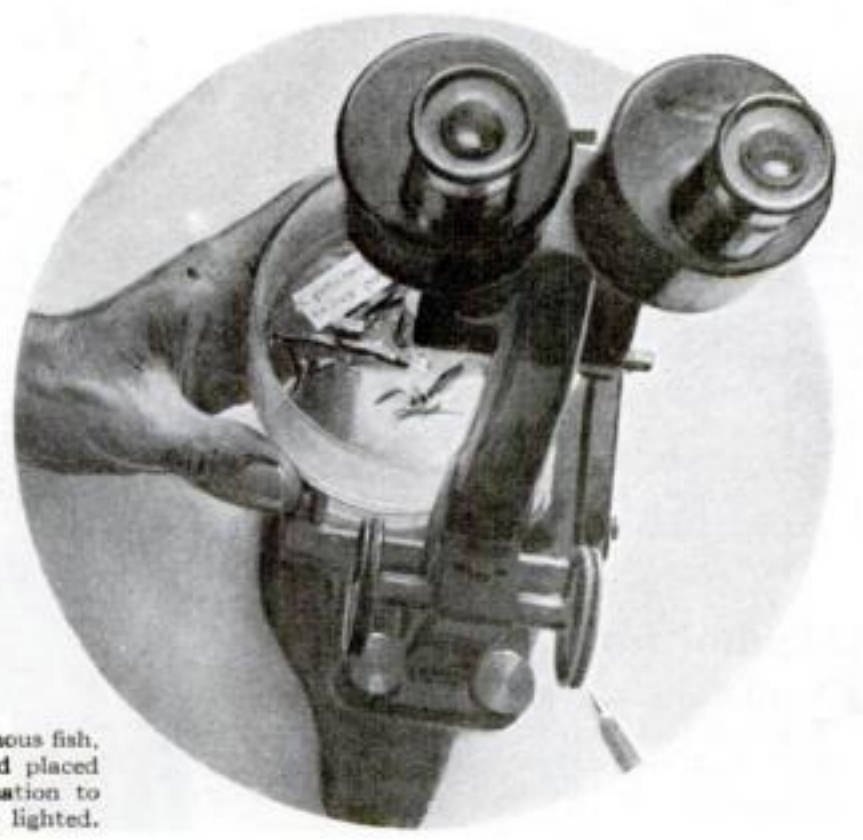


A net full of grotesque creatures from the deep, aglow with lights of many colors, fighting and devouring one another. Top: A black Astronesthes fish, or "Eater of the Stars," pursuing its luminous prey near the surface of t e water.



Beebe recovering the flag of the Explorers' Club from a large circular net, after it had been "flown" about a mile and a half below the surface of the sea.

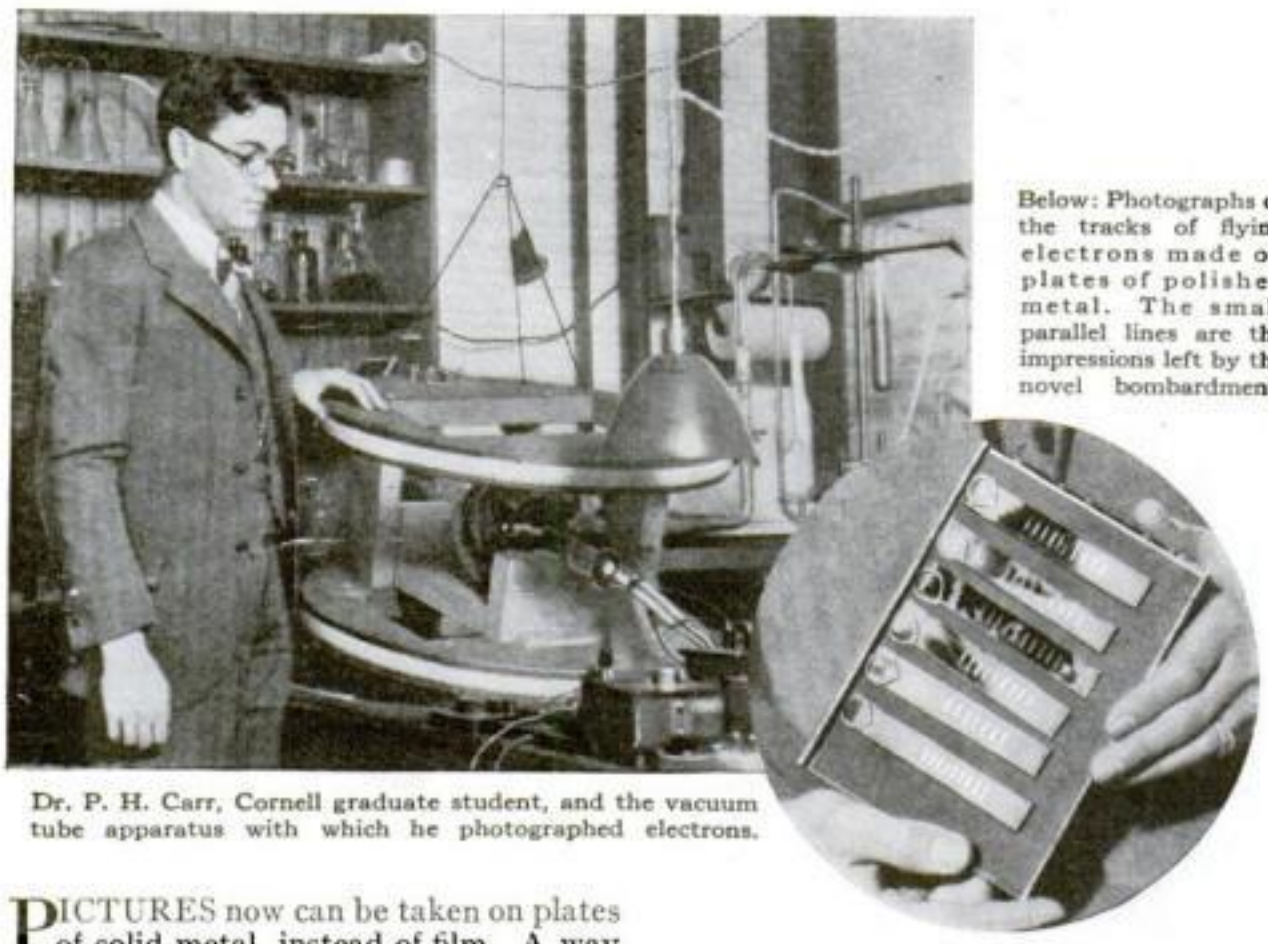
Diving at Nonsuch Island, a speck of land off Hamilton, Bermuda. Miss Gloria Hollister, technical associate of the expedition, holds a portable diving helmet used in shallow waters.



Right: A living specimen of luminous fish, preserved in a labeled bottle, and placed under the microscope for examination to learn how its deep-sea lamps are lighted.

PROGRESS AND DISCOVERY

Speeding Electrons Photographed on Metal



Dr. P. H. Carr, Cornell graduate student, and the vacuum tube apparatus with which he photographed electrons.

Below: Photographs of the tracks of flying electrons made on plates of polished metal. The small parallel lines are the impressions left by the novel bombardment.

PICTURES now can be taken on plates of solid metal, instead of film. A way to develop pictures made on gold and other metals is the recent discovery of Dr. P. H. Carr, Cornell University.

The new method of photography without light is not intended for taking snapshots of the baby, or the suburban home. Instead, it pictures the track of flying electrons—those tiny electric charges most familiar as the invisible streams of power that radiate from a radio tube's hot filament. The pictures reveal vertical lines, slim where high-powered beams struck and broad for lower power, and may lead to important discoveries of the ways that electrons behave. Hitherto ordinary photographic plates, usable only in the dark, have been pressed into service for studying electrons' tracks, but the new plates record in broad daylight. They are more sensitive than film for electrons flying at comparatively low speed and nearly as sensitive at high speeds.

The discovery was made by chance. To produce X-rays an electron beam bombards a metal target in an X-ray tube. Dr. Carr, working under the direction of Dr. F. K. Richtmeyer, Cornell physicist, noticed the pitted condition of an X-ray target after use and wondered whether any traces of such a bombardment could be revealed by "developing," even before visible rough spots appeared. He shot electrons from a vacuum tube at a polished gold plate and found he could bring out the impression made by the electrons with mercury vapor. Silver and copper plates revealed a recognizable picture when "developed" with iodine, and zinc plates with hydrochloric acid.

Alcohol from Natural Gas

GRAIN alcohol from natural gas is the latest feat of manufacturing chemists. It has been developed by the Union Carbide Company by "cracking" the gas into ethylene (a new anesthetic of great possibilities) and converting ethylene into ethyl (grain) alcohol by a new method of combining ethylene with water.

Automatic Chemist Saves Work in Laboratory

NOW comes the "automatic chemist"—a device that relieves the chemist of one of the most tedious parts of making an analysis. As recently demonstrated in New York City, the automaton measures either the acidity or alkalinity of a solution, or the amount of certain ingredients in it. When the measurement is completed it rings a bell and lights a red light.

This fundamental operation, known to chemists as "titration," is important in every application of chemistry, from making shoe leather to the testing of a city's water supply. A careful titration may take half an hour of a chemist's time, but the mechanical chemist requires no attention after the start.

A glass beaker contains a measured quantity of the transparent solution under test. A few drops of a solution such as phenolphthalein, which is red in the presence of alkali and colorless in acid, is added. If it turns a vivid pink, indicating that the solution in the beaker is alkaline, acid from a graduated tube is allowed to drip into the beaker. A beam of light from a lantern shines through the beaker while the test is in progress, falling upon a light-sensitive electric cell opposite. When the solution suddenly turns white again at the addition of one additional drop of acid, the "electric eye" turns off the acid and rings the bell. The amount of acid required to neutralize the alkali may then be read from the graduated tube, giving an index of the original solution's alkalinity.

The operation may be reversed, adding alkali instead, when acid solutions are to be tested. Since the human eye is a poor judge of the exact moment of color change in any such test, the automatic chemist is likely to be more accurate than a man.

Demonstrating automaton which controls a chemical experiment without human aid.

Poor Food, Not High Life, the Cause of Ills

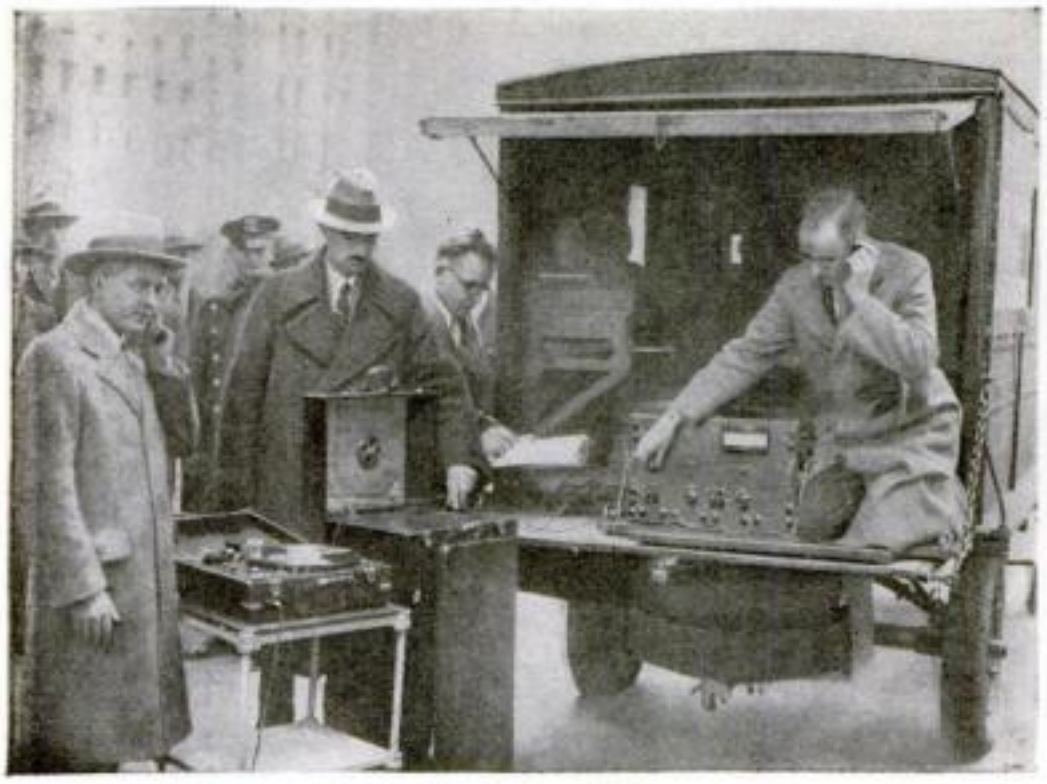
IN A recent report to the American Medical Association comparing the diets and diseases of 501 selected patients, Dr. Lovell Langstroth, of San Francisco, finds that the ordinary "business man's" or "society woman's" diseases are due not to fast living but to bad food. Foods are either "protective" or "nonprotective," he says. Protective foods are those containing plenty of vitamins, minerals, and other principals believed to protect the body and keep it in working order. Such foods are eggs, milk, fruit, lettuce, and vegetables. But these make up only twelve percent of the American's diet, which is too little, Dr. Langstroth declares. Among the nonprotective foods, of which Americans partake altogether too freely, he finds, are sugar, cream, mayonnaise, potatoes, and sweet desserts.

Dr. Langstroth lays arthritis, heart disease, high blood pressure, chronic stomach trouble, and other diseases at the door of a nonprotective diet.

An Artificial North Light for Color Matching

IN THE past artists have coveted the daylight from the northern sky for matching their colors, believing it the best possible. But A. H. Taylor, physicist of the National Lamp Works at Cleveland, Ohio, recently told the Illuminating Engineering Society that northern skylight varies in intensity from day to day and even from hour to hour. And he added that the best light anyway for color matching was the white light corresponding to noon sunlight on a clear summer day. But this light can only be had for a short time during the day in the right season and the right weather.

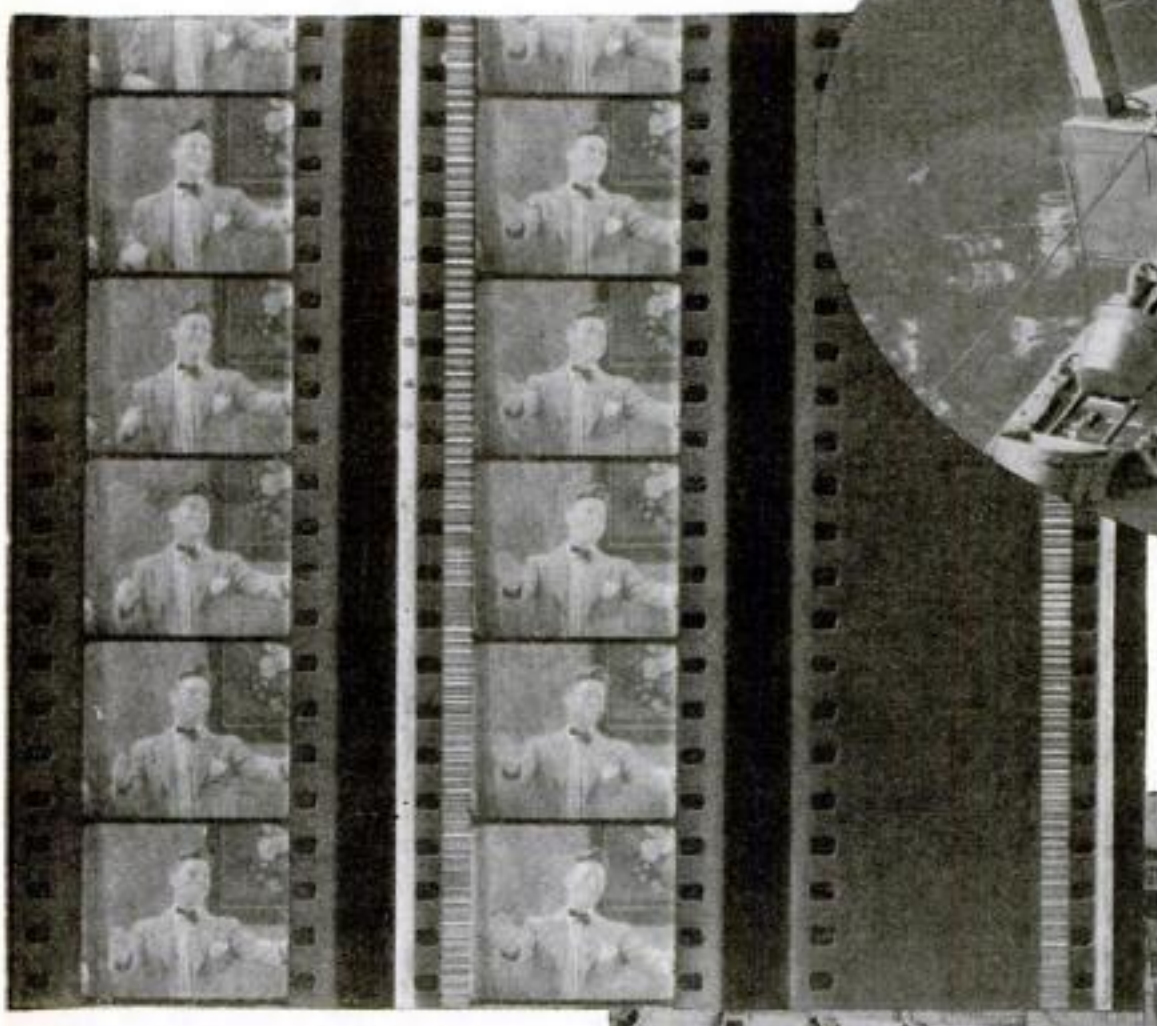
Taylor suggests an artificial solution of the difficulty. Substitute, he says, an artificial sun consisting of a tungsten incandescent lamp with color filters. This artificial north skylight can be produced at a cost three times that necessary for the production of white light. In using it, however, artists should bear in mind that it is of a bluish quality and makes pink, lavender, magenta, and purple appear bluer than they should, while it tones down yellow, orange, and red.



Measuring New York City Noises

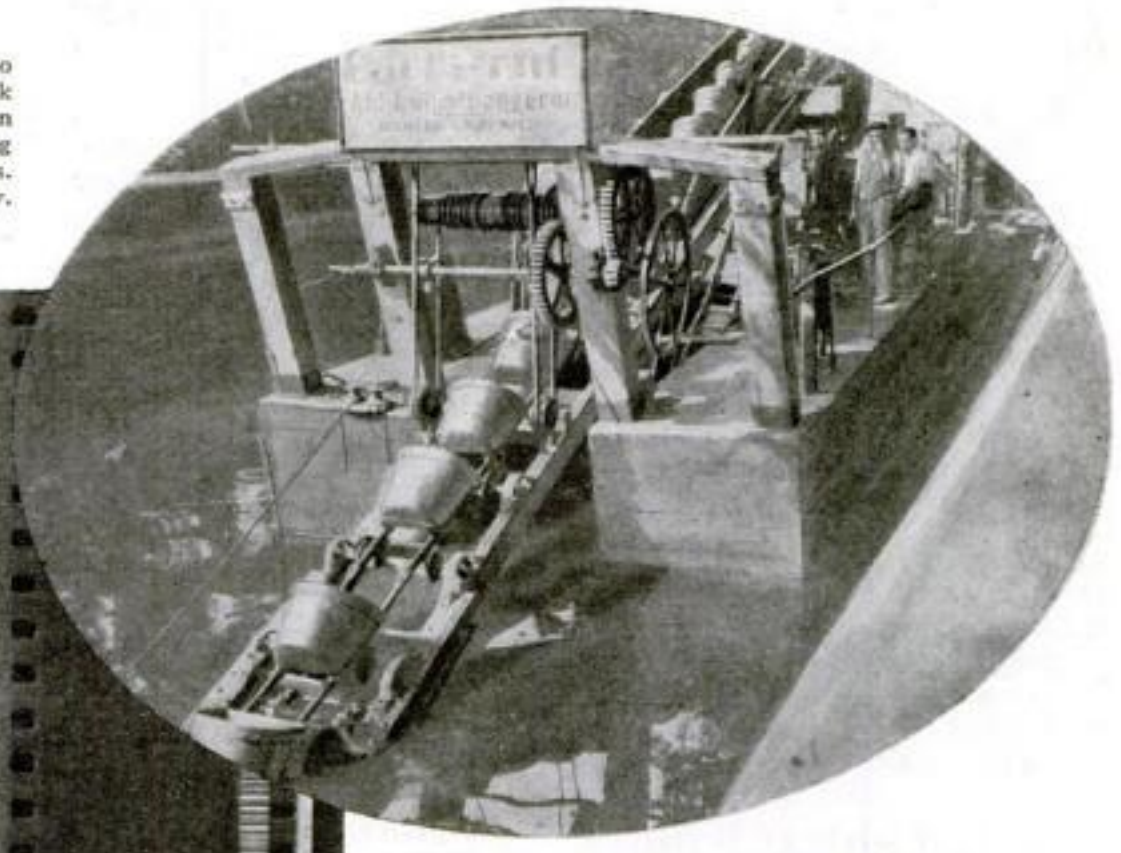
For several months a truck carrying delicate instruments to measure the intensity of noises has been roaming New York streets gathering evidence in the city's antinoise campaign (P. S. M., Jan. '30, p. 17). Health officials are seen here making tests with the instruments, which give visible and audible records. These serve for comparisons between various sections of the city.

"Diamonds from Sugar." By subjecting ordinary table sugar to enormous heat and pressure in the laboratory, Prof. J. M. Hershey, of McPherson College, Kansas, claims to have produced diamonds the size of a grain of sand. Larger artificial gems are possible, he says. He is shown with his apparatus.



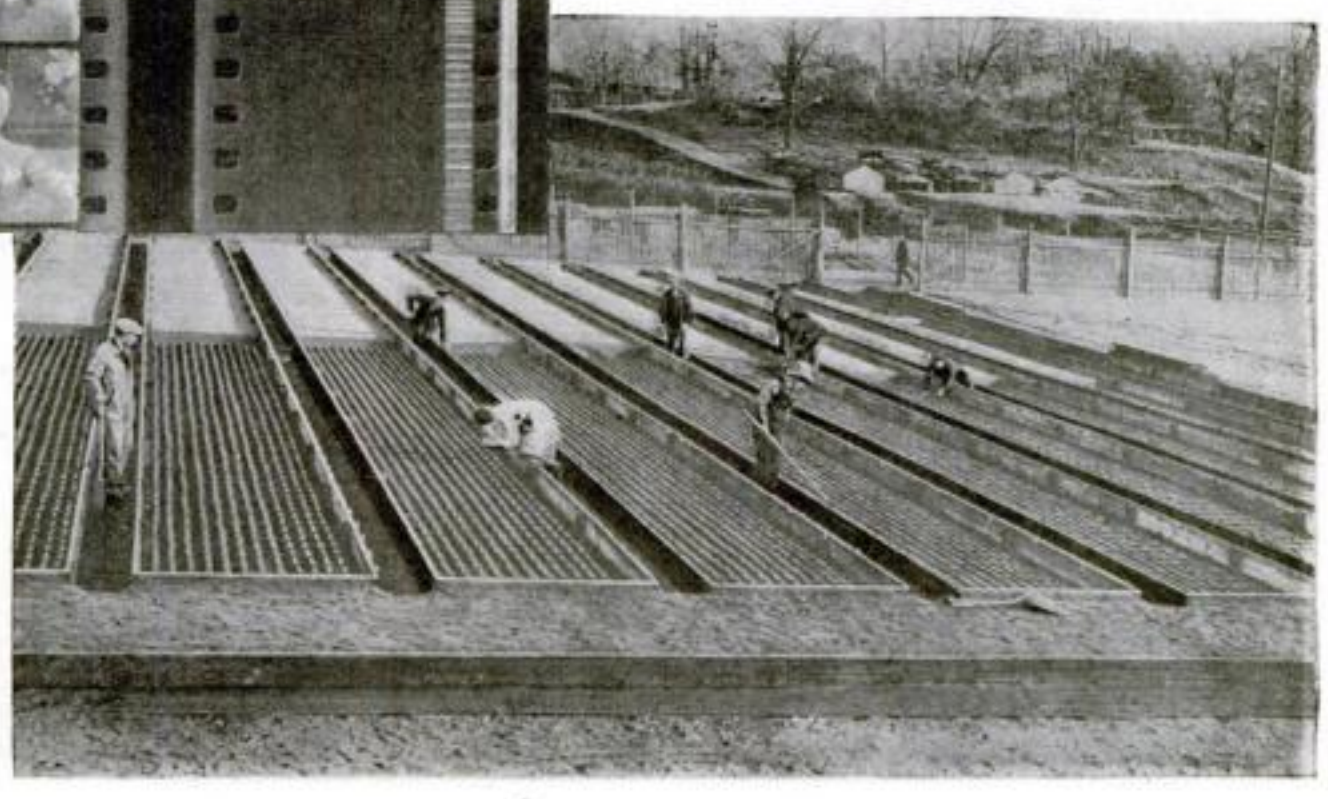
Fitting Voices to Faces

To aid movie film editors to synchronize pictures and sounds for the talkies, a new machine called "moviola" has been devised. Into it the editor feeds the picture film (left) and the sound film (right). By listening to the sounds and watching the picture he superimposes one record upon the other (center).



Bucket Dredge Cleans Canal

This huge dredging machine recently advanced along the Landwehr Canal, Berlin, Germany, clearing the waterway of an accumulation of debris and sediment. The buckets, rising from the bottom, dumped their load into a tank; the water drained out, leaving the sediment.



An Electrical Garden

To speed the growth of plants in a test garden at Stockholm, Sweden, electric heat is applied to the soil. Beneath the beds are laid lines of resistance wires about a foot apart, as shown at the right. These are sheathed with brick and then covered with a layer of soil a few inches in thickness.

PROGRESS AND DISCOVERY

Setting the Pace in Aviation

Around the Air Circuit for a 5,000-Mile Record—New Amphibians for Forty Passengers—Other Flying Progress

ALL distance records for airplane flight apparently have fallen, recently, with the trip of Dieudonne Costes, French aviator, and his companion, Paul Codos, over a closed circuit in France. Although the mark actually attained has not been checked officially at this writing, preliminary estimates place it close to 5,015 miles. This exceeds all records for either a flight around a measured course or a straightaway flight from point to point. To achieve it, the flyers winged their way for fifty-two hours over a triangular course of about 206 miles. The distance covered was a tribute to the cruising radius of the modern airplane.

Only a short time ago Costes and another French flyer, M. J. Bellonte, smashed all straightaway distance records by a flight from Paris to Manchuria. The Aero Club of France gives the official distance of this flight as 4,912.01 miles.

Safety Contest Winner

SOLE survivor among the fifteen planes submitted for the Daniel Guggenheim Safe Aircraft Contest, the Curtiss Tanager, a slotted-wing cabin biplane, recently won the grand prize of $100,000. No finals were necessary in the contest, because this was the only machine to pass the eighteen exacting tests designed to find a "foolproof" airplane.

Besides the slotted wing, which is a small auxiliary wing serving to minimize danger from stalls and spins, the machine has another radical feature in what are called "full floating" ailerons or balancing flaps. These are unsupported, tilting flaps placed at the tips of the lower wings, and are said to give increased control. The airplane carries three passengers. A duplicate of this airplane is expected to be developed for commercial production.

40-Passenger Amphibians

LAST month POPULAR SCIENCE MONTHLY described a fourteen-passenger amphibian plane, at that time the largest plane in the world that could alight either on land or water.

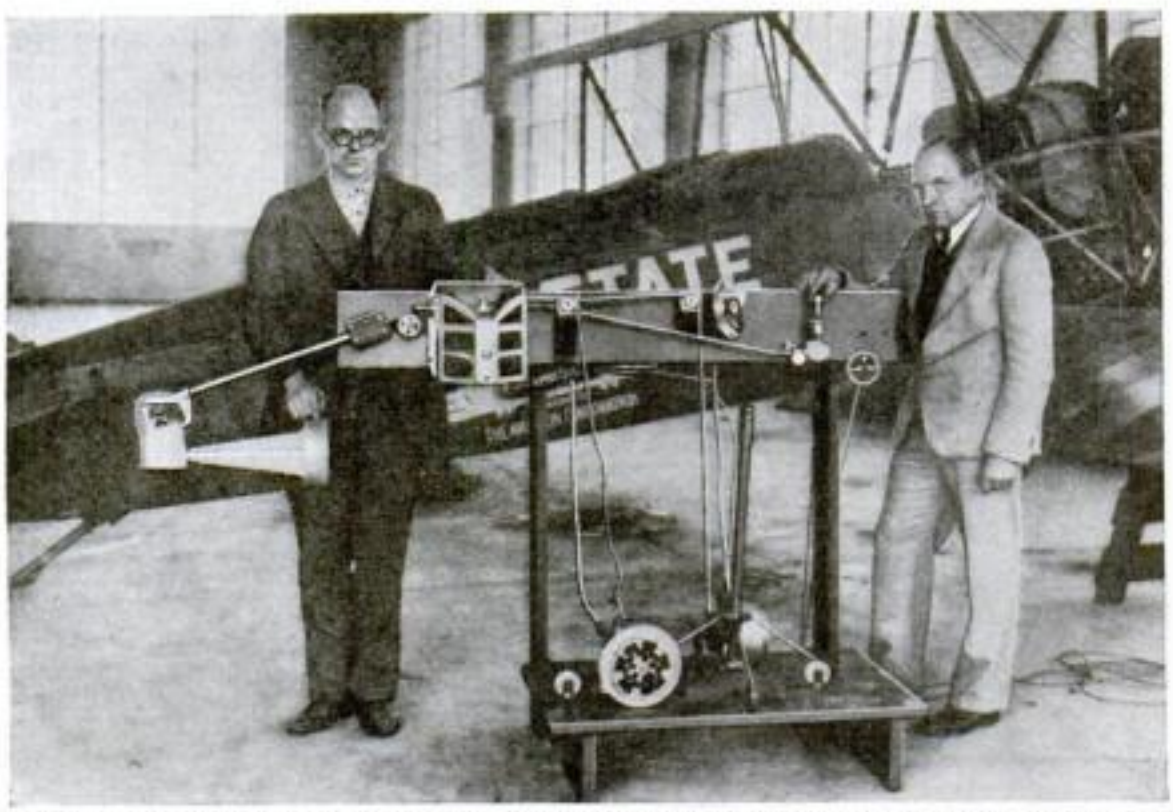
Now construction is announced of two forty-one-passenger Sikorsky amphibian planes, by far the largest amphibians in the world and even among flying boats comparable only to the Dornier giant *DO-X* in size. When placed in service next December, they will inaugurate twenty-four-hour service between New York City and Cristobal, Canal Zone.

Testing the use of enormous shock-absorbing balloon tires on a big plane at Los Angeles. Only seven pounds pressure required.

The airplane carries three passengers. A duplicate of this airplane is expected to be developed for commercial production.

Known as the S-40, the new type has a wing spread of 114 feet. Four motors will drive the huge ship at a cruising speed of 108 miles an hour. The power plant has a total of 2,300 horsepower.

Passengers traveling from New York to Cristobal will fly by night from New York to Miami in small planes, where they will board the giant S-40's in the morning. Sitting in comfortable armchairs, they will be whisked over the 1,200-mile jump across the Caribbean Sea to Cristobal, stopping at Kingston, Jamaica, or on the Honduras coast for refueling.



Designed as an automatic stabilizer, this device combines a vane and pendulum mechanism said to govern a plane's controls to restore balance. Inventor is O. W. Greene of Elyria, O. (left).

Adding 75 Feet to R-101

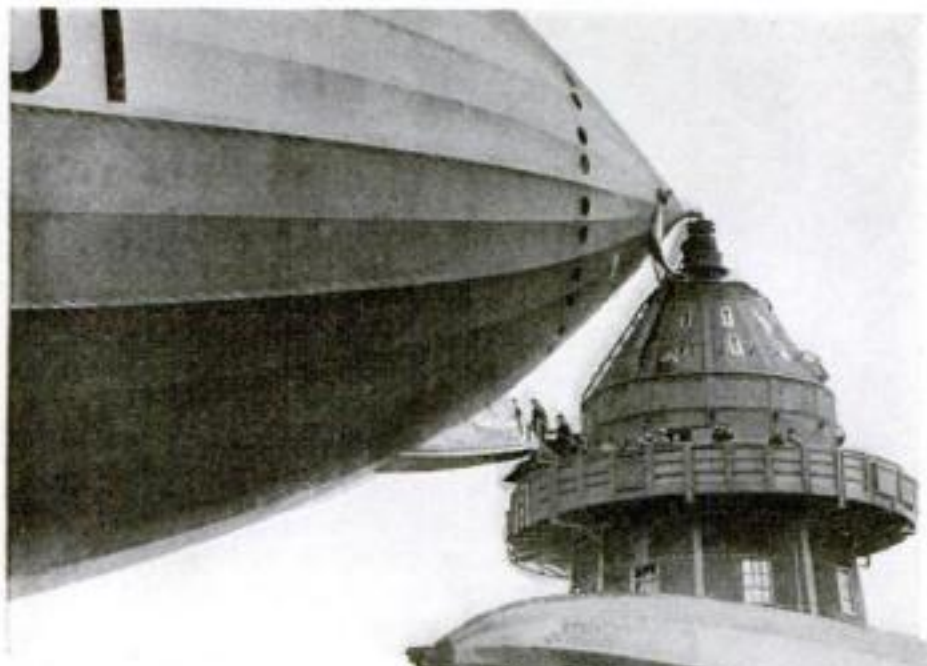
AN EXTRAORDINARY surgical operation upon Britain's recently-completed airship, the *R-101*, is to add a seventy-five-foot piece to her midsection. The great hull will be cut in two and the extra section grafted in, it is announced. This action follows reports that the lifting capacity of the *R-101* proved disappointing in trial flights.

Addition of 500,000 cubic feet of gas capacity in the new cell will bring her total bulk to 5,500,000 cubic feet, making her the largest in the world by an increased margin. It will add six tons to the useful load that can be carried. When the operation is completed the airship will be about 800 feet long. The novel oil-burning motors of the *R-101* may also be replaced with lighter motors.

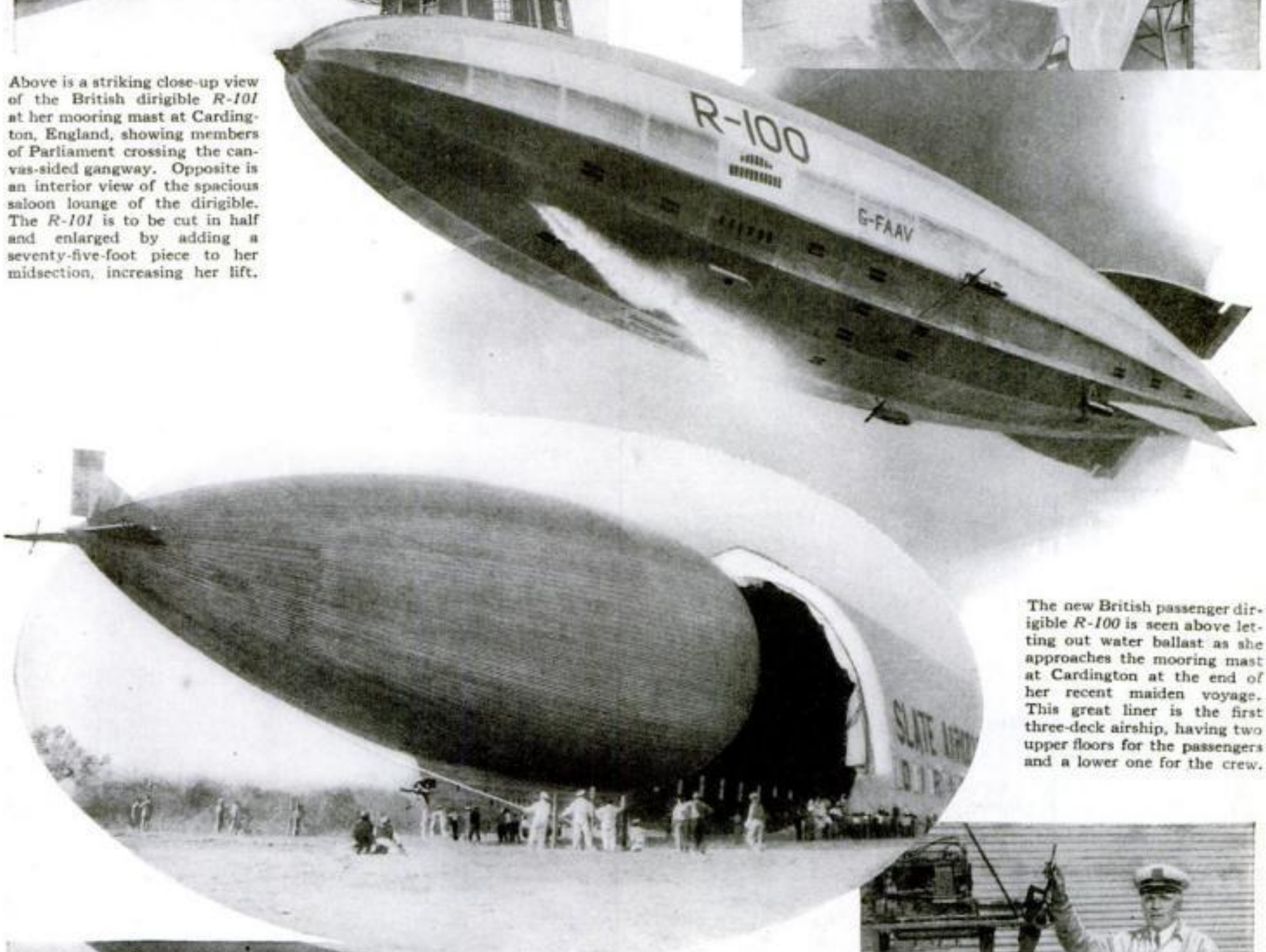
With the recent launching of the *R-100* on its first trial flight after a delay of many weeks, Britain has the two largest airships in

(Continued on page 54)

Close-Up Views of the World's Newest Dirigibles



Above is a striking close-up view of the British dirigible *R-101* at her mooring mast at Cardington, England, showing members of Parliament crossing the canvas-sided gangway. Opposite is an interior view of the spacious saloon lounge of the dirigible. The *R-101* is to be cut in half and enlarged by adding a seventy-five-foot piece to her midsection, increasing her lift.

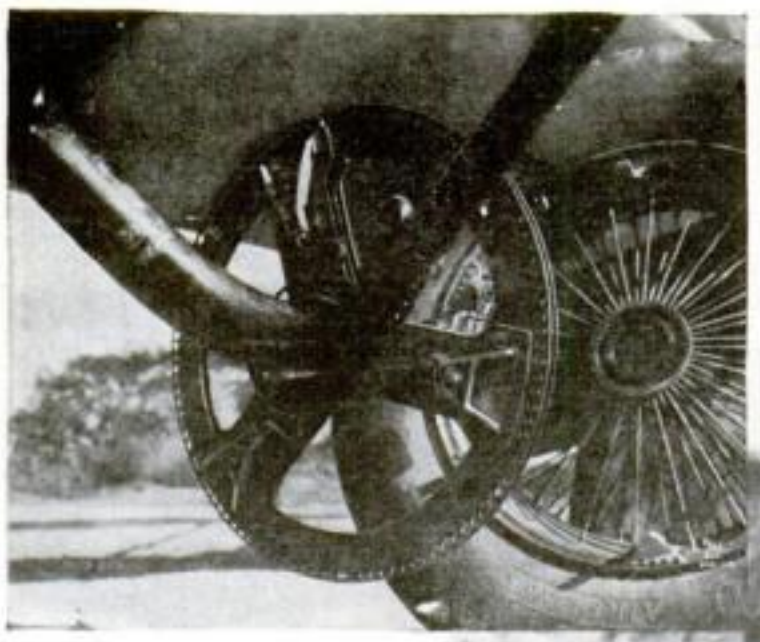


The new British passenger dirigible *R-100* is seen above letting out water ballast as she approaches the mooring mast at Cardington at the end of her recent maiden voyage. This great liner is the first three-deck airship, having two upper floors for the passengers and a lower one for the crew.

Walking the Slate all-metal dirigible *City of Glendale* out of its hangar at Glendale, Calif., for a trial flight. An accident prevented the take-off. The sun, beating on the metal envelope, expanded the gas. A safety valve stuck and a seam burst near the ship's top.

One of the innovations of the Slate airship is an elevator for lowering and raising passengers. At the left the ground crew is seen placing the elevator in its shaft beneath the cabin. Another novel feature is a blower used instead of a propeller to drive the craft.

Capt. Thomas Slate, inventor of the all-metal airship, standing beside a small motor generator which supplies current for the elevator.



Working on the landing wheels, the new airplane brake at the left is said to stop the heaviest plane within 300 feet. Hydraulic pressure forces a stationary plate against a disk attached to the landing wheel. In the illustration the wheel is removed so as to show the mechanism.

Racing against death in a thousand-foot plunge, an instructor and student landed in this burning plane recently at Roosevelt Field, N. Y. Both jumped to safety before camera clicked.

the world. The 709-foot *R-100* is the first three-deck airship, using the two upper floors for passengers and the lower one for the crew. Duralumin girders of new tubular design for the framework of the hull can be removed or replaced with ease. In other airships it is necessary to cut out a damaged piece and rivet a new one in. For the first time, also, a method has been developed in the *R-100* for changing the engines while the ship is at the mooring mast. The first long flight of the new ship is expected to be to Canada.

Automobile Engine Drives Plane

AN AUTOMOBILE engine drove an airplane successfully in a recent test at Dayton, O. The air-cooled engine, which had driven a car of standard make to the flying field, was removed from the automobile and transferred to the airplane. It supplied adequate power during a flight that asted several hours.

Engineers view the test as significant because of the possibility that airplane and auto motors may become more or less identical in design with engineering advances. According to H. H. Franklin, motor car manufacturer, there is no reason why a motor should not be made that will function equally well in airplane or car. Automobiles may be the principal gainers, the lightweight, efficient motor developed for aviation being generally regarded as the highest engineering development of gasoline engines.

Next—Beryllium Planes?

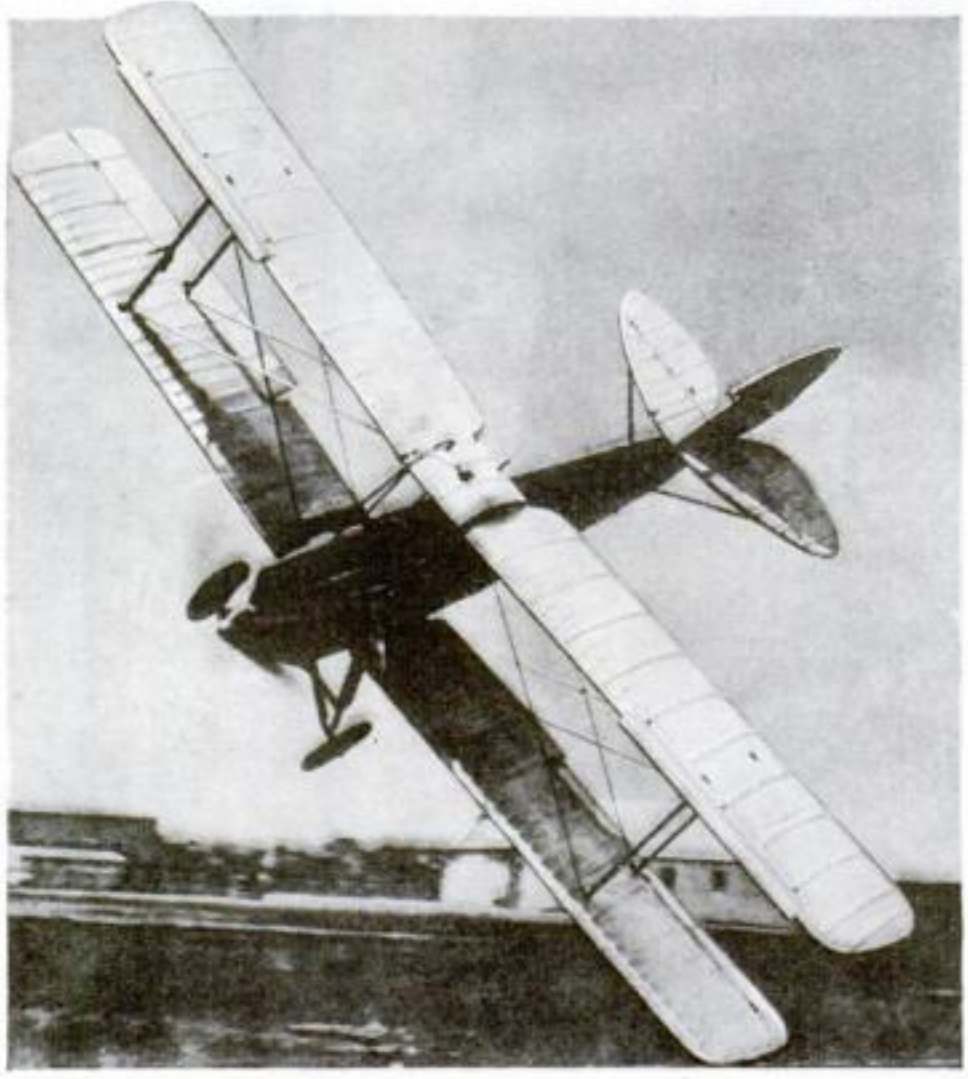
WILL airships and airplanes of beryllium be next? That duralumin, lightweight alloy of aluminum long used for building dirigibles, may have a future rival in this little-known and costly metal is the suggestion of the United States Bureau of Mines in a recent report. The National Advisory Committee for Aeronautics is planning to test the use of beryllium for airplane construction, the report adds.

Beryllium, also known as glucinum, is one of the very light metals. It is a third lighter than aluminum and duralumin, which is an alloy of aluminum and magnesium, with small quantities of copper and manganese, f about the same weight of aluminum. In addition, beryllium is exceptionally hard and strong, an unusual combination with lightness. Should its present almost prohibitive cost of about $200 a pound be reduced by quantity production, some experts see it as the new and logical light metal for aviation use. At present its application has mainly been restricted to such odd jobs as making parts of X-ray apparatus and the electrodes that are used in neon advertising signs.

New Curved Radio Beam

FOLLOWING a curved radio beam home is the newest way for an airplane flying in fog to land. It was demonstrated the other day at Washington, D. C., with the aid of apparatus perfected by the United States Bureau of Standards.

In this method a beam transmitter is buried, flush with the ground, in the center of a landing field. The beam projects nearly horizontally across the field, slanting slightly upward for a distance of about two miles; then it curves sharply upward into the sky. An approaching airman is informed by radiophone in which direction the beam is pointing. He circles the landing field until he picks it up through dials on his instrument board; the beam is about twenty feet wide. Then the pilot simply flies down along the beam and safely onto the field. Two vertical beams near the end, at fixed distances from the field's center, give the pilot his altitude and tell him when to pull back his control stick for landing his plane safely.

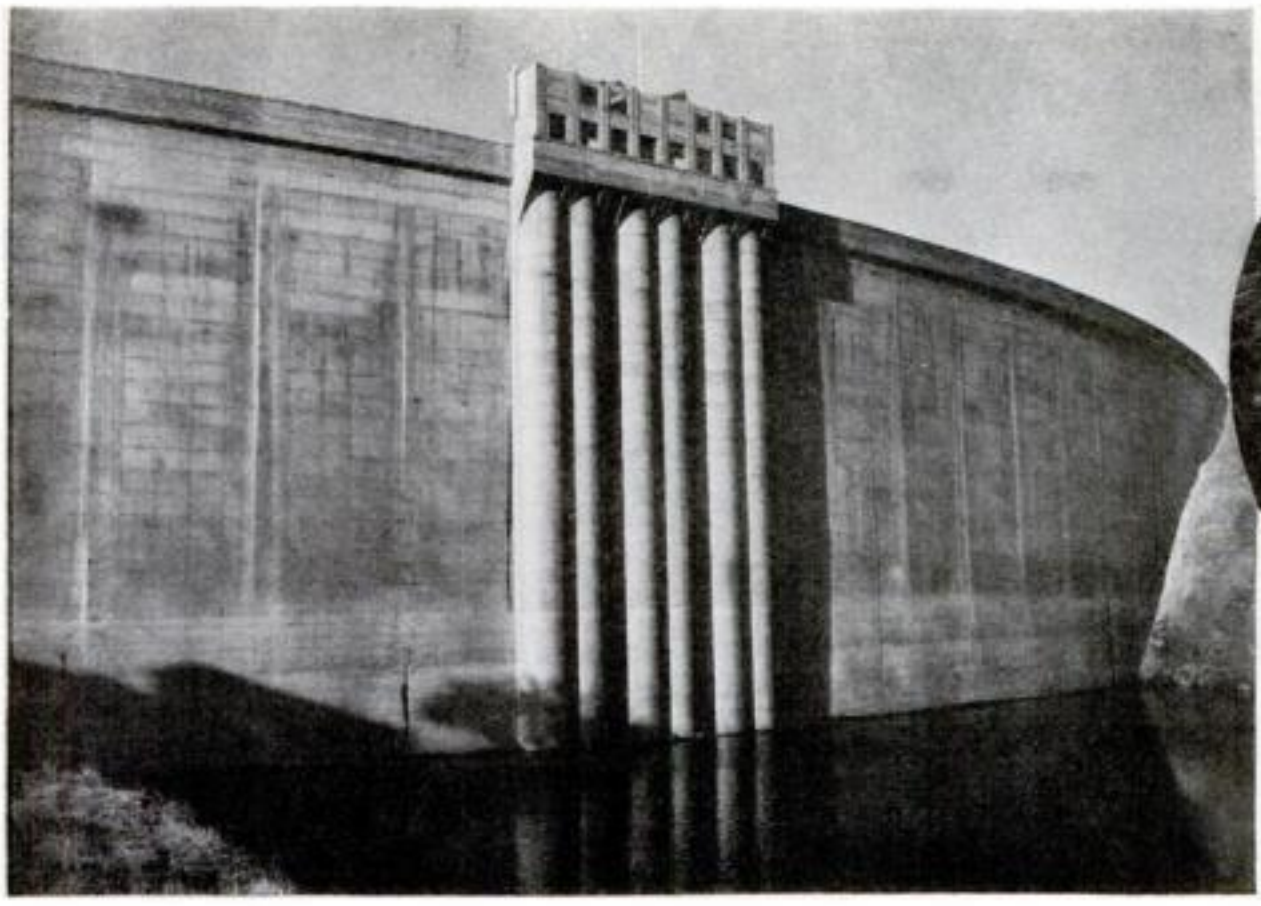


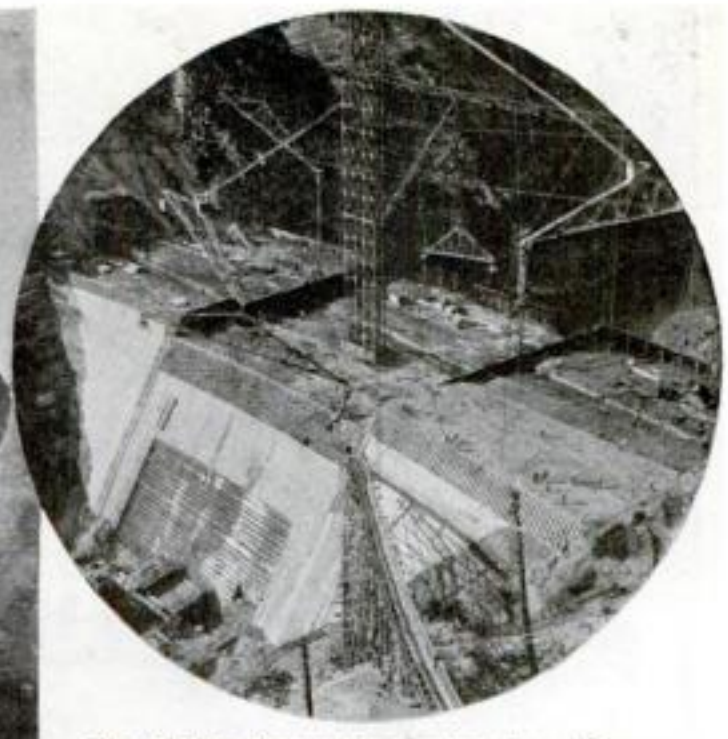
And then it crashed. This unusual photo was taken an instant before the left wing of a plane hit the ground at Mascot Airdrome, Sydney, Australia.

Mail Pilot Flies Million Miles

MORE than a million miles covered in the air is the extraordinary record of E. Hamilton Lee, thirty-five-year-old air mail pilot on the western transcontinental route. In all that distance, he has never had a major accident.

Since he began piloting, in 1913, he has flown between 10,000 and 12,000 hours in forty-five different makes of airplanes. His career, which started with barnstorming, includes among other exploits the successful dropping of food to eleven ice-bound lumberjacks marooned on South Fox Island, in Lake Michigan, after five other pilots had failed in the attempt.





The Pardee Dam under construction. Concrete from four mixers at the top of the steel tower poured down to the dam through chutes. At left: The completed dam, 358 feet high, finished a year and a half ahead of schedule.

Build Great Dam in Record Time

Workmen Labor Night and Day to Save California Cities from a Water Famine

By EARLE DUFFY

WHEN nine cities in the East Bay region of California were faced with a water famine, engineers working day and night completed one of the world's mightiest dams a year and a half ahead of schedule. Unusual high-speed methods erected this 358-foot-high structure, the Pardee Dam on the Mokelumne River, in world's record time.

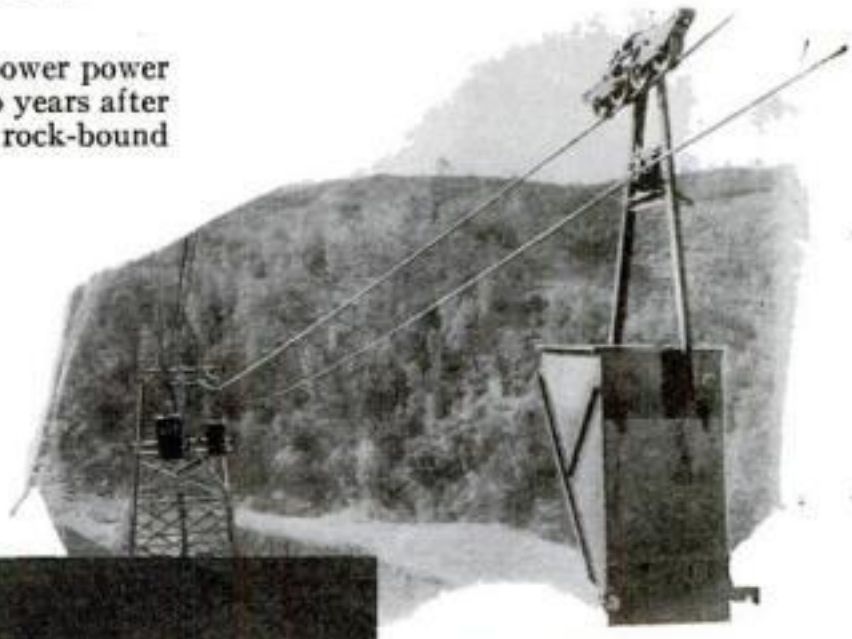
One of the builders suggested that an aerial tramway three and a half miles long, one of the largest heavy-duty cableways ever projected, would save constructing a twelve-mile railroad. The cableway was built, and carried 250 tons of sand and gravel hourly for twenty months.

When unlooked-for floods threatened the dam while the engineers were racing against time to complete it, they built a huge flume to carry the flood waters and the work went on. Workmen suspended on ropes, like monkeys on strings, dangled perilously above the swirling torrents.

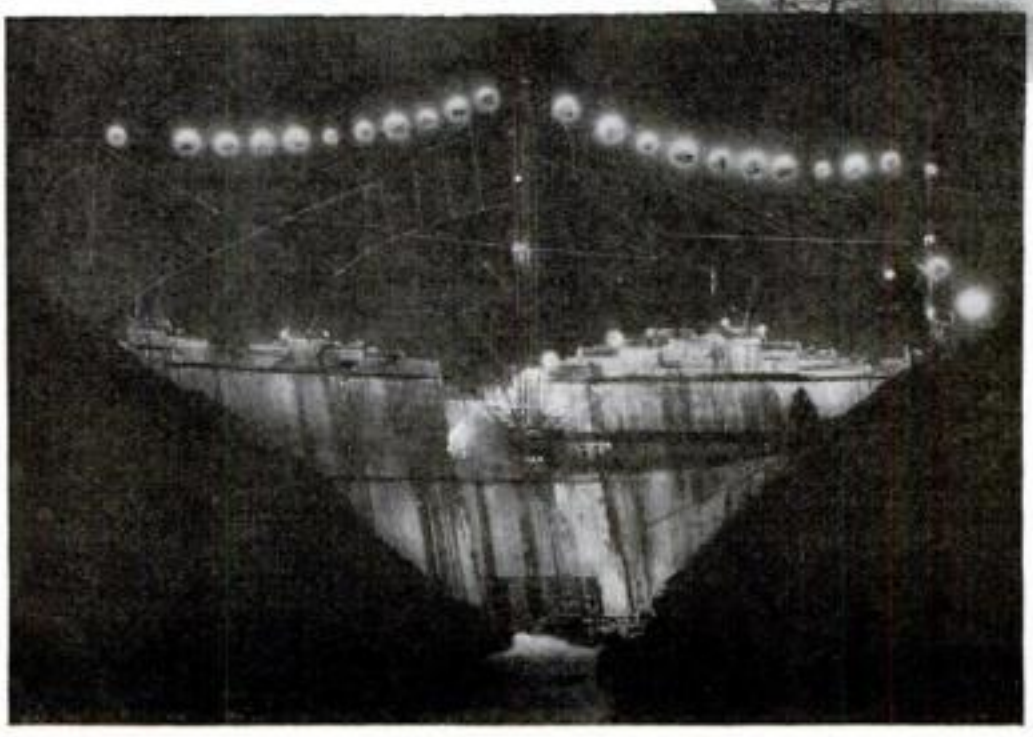
Most of the concrete for the dam went into place after dark. Records fell as the racing workmen toiled under the glare of floodlights. In relays they placed 615,000 cubic yards of concrete—enough to prolong the Washington Monument more than a mile skyward. Concrete from four giant mixers, hoisted to the top of a high steel tower, shot down to the bulwarks of the dam through chutes and spouts familiarly known as "elephant trunks."

One of the new records achieved was the placing, by this method, of 514,000 cubic yards of concrete in a single year. The whole dam, together with a 20,000-horsepower power house, was completed just two years after construction began in the rock-bound gorge.

The completed structure forms a dam known as the curved gravity type. Its height from the river bed is not far short of that of the 385-foot-high Pacoima Canyon dam in southern California, the highest dam in the world at this writing.



This three-and-a-half-mile aerial tramway saved the construction of a railway twelve miles long.



Under the glare of powerful floodlights workmen toiled through the night placing the concrete. Preparations for this work were made in daytime.

Other dimensions of the new dam are equally impressive. Its curved crest measures a quarter of a mile long from one side of the gorge to the other. The dam backs up a lake of 222,000 acre feet; that is, enough water to cover the whole District of Columbia about five feet deep. Through the 847-foot-long spillway, a cataract of water will pour in flood times with more than half the volume that goes over Niagara Falls.

The wolf. Science has discovered a common ancestor of this ferocious animal and the police dog on the opposite page.

Was Your Dog Once a Wolf?

By

STEPHEN SHERMAN

SEVENTY-NINE breeds of dogs, among them rare and little-known varieties, will constitute soon the greatest dog show on earth, at the Peabody Museum of Natural History in New Haven, Conn. It will be a show without a bark, for the novel collection is not of living dogs. Instead, skulls, skeletons, and complete mounted specimens of all present-day breeds recognized by the American Kennel Club, and their wild ancestors, will be there.

The purpose of the unique exhibit is to enable future generations of students and scientists—perhaps 2,000 years hence—to compare the dogs of their day with those of the twentieth century. Already skulls of the Irish wolfhound, the Newfoundland, and entire skeletons of the cocker spaniel, French bulldog, and pedigreed bloodhound, with their skins for mounting, have been received. A prized specimen is that of Togo, the Alaskan dog that carried diphtheria serum to Nome, Alaska. Under the care of Leon F. Whitney, authority on genetics, or the laws of inheritance, the exhibits will attempt to summarize present knowledge of how, through evolution, all these highly modified breeds came into existence.

Only recently has such a task become possible at all. Recent scientific work has solved, in part at least, many mysteries about the dog and its history.

What possible relation can there be, for example, between the barrel-shaped bulldog and the slim, fleet grayhound, or between the midget Chihuahua and the lumbering Great Dane? How did such breeds come into being, and are certain ones dying out? Is the German police dog, or shepherd dog, almost totally wolf? Is the dog descended from the wolf? And when, and where, did the first dog originate?

Not until the beginning of the present century could geologists and zoologists commence to answer questions such as these, despite the knowledge of evolution acquired in the century past. It has been a slow yet thrilling task. A random specimen, a skull or a few fragments of bones dug up in some odd corner of the earth, has often supplied a missing chapter of the story. A skull is a treasured find; for, according to experts of the American Museum of Natural History, it shows most strikingly the march of evolution to higher types. Thus, within the last few years, the story of the dog and its forefathers has been shorn of nearly all its mysteries.

Back in that remote epoch known as the Tertiary geologic age, three million years before men were building skyscrapers and flying the Atlantic in airplanes, the story of the dog begins. All the evidence indicates that over the vast wastes of Europe and Asia, in that day, ranged the Creodontes, the four-footed heavy-set ancestors of all the carnivorous animals known today. Before the Tertiary age had reached its halfway mark, the only family of these destined to survive until the present day had appeared—strange creatures that rolled into one the racial characteristics of the dog, the bear, and the zibet, or Bengal civet cat.

A group of coyotes at night. These are more wolves than dogs, but they belong to the same family tree.

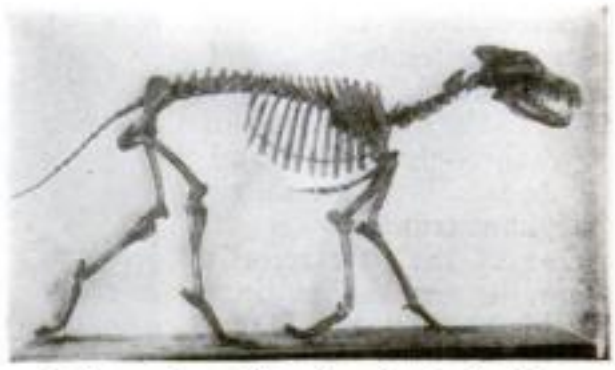
Born of the fierce struggle for existence, distinct types developed among these animals. Toward the end of the great Tertiary age there appeared a new race of four-footers—the family, or genus *Canis*, as it is known to science, in other words the "genuine dog."

THIS was the ancestor of all dogs, the primitive root from which all dog pedigrees of the present day have sprung. Exactly what he was like will probably never be known unless some lucky explorer discovers his fossilized skeleton—yet his ghost looms out of the past, a real though intangible presence.

One of the many species of the original *Canis* in particular reached a high state of development. He was *Canis lupus*—Latin for "wolf dog"—the Adam or first parent of all dogs of today, excepting a few wild varieties. And—it is inescapable—he was also the parent of the modern wolf. Probably Lupus himself looked more like a wolf than a dog, though this cannot be more than speculation. At any rate, the answer to the question, "Are dogs descended from wolves?" is "yes," with reservations. The modern dog is descended from an ancient ancestor that may be called a wolf or a dog with equal justification. It would be no more accurate to say that all present-day dogs have wolf blood than to say that human beings have monkey blood, even when common ancestry of the last is admitted.

In both cases the common ancestor is so remote, and the changes through the ages so marked, that by now the strains are separate. That is the story of the dog's history as it is summed up by the great German authorities, Studer and Stephanitz, and specialists at the American Museum of Natural History hold it to be a true one.

Domestic or tame dogs, and wolves (including coyotes, or prairie wolves), are not the only branches of the family tree



Skeleton of a prehistoric wolf, *Canis dirus*, unearthed recently from a California tar pit.

Science Traces the Shepherd Dog, Wolfhound, Spaniel, Bulldog, and All the Others, Back to a Common Ancestor Which Lived Millions of Years Ago, and Discovers Interesting Facts to Explain Why a Great Dane Differs from a Pekinese

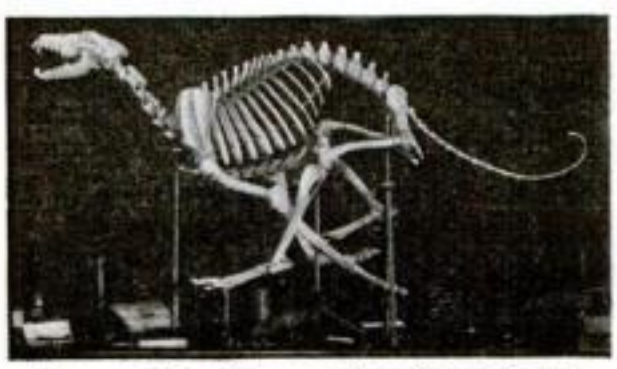
A typical German shepherd dog, commonly known as a police dog. It is of pure breed with no modern wolf blood in its veins.

that starts with the ancient family of *Canis*. At this early time branched off the marten dog and the "Otocyon," with spoon-shaped ears; also wild dogs like the dingo of Australia and the "Icticyon," or forest dog. Distinct breeds appeared in southern Asia and in Siberia, the ancestors of those of today. Other descendants were the jackal, the Alpine dog, the "Lyacon" or hyena dog, and the South American species known as Thous.

ON the so-called wild dogs, in fact, hinges the scientific proof of the story just recounted. An explorer named Trouessart, hunting early in the 1900's near Quito in the South American Andes, discovered a curious wild creature. It did not look like a dog, yet the arrangement of its teeth showed that it undoubtedly was. This dog, the *Icticyon rivetti*, supplied a "missing link" in a pedigree that could be traced right back to the family of *Canis*. Thus it confirmed the branching off of dog families as long ago as the Tertiary geologic age.

A few years ago, an English explorer named Tanning reported that he had found a new kind of wild dog no bigger than a rat in the fastnesses of western Australia—a strange creature that fed indiscriminately on lizards and bugs. If this is an authentic dog, it is one more offshoot of the single ancestor that populated the world with dogs and wolves.

Knowing the story of the dog's evolution, it is possible to reconstruct the way that the diverse breeds came into existence. Grayhounds of the southern Mediterranean, Tibetan and "pariah" dogs, and dingoes are traced by Studer to a single common ancestor in northern Europe and Asia. Of these, the wild dingo, bushy-tailed, wolf-faced, and reddish-brown, reached Australia in an odd way. It is supposed to have been carried there, tamed, by a prehistoric people who were driven out of Europe. Today there are savage tribes along the Herbert River, in northern Australia, who



A remarkable action mounting of a wolfhound skeleton. Compare it with that of the wolf.

The bulldog, above, and the wolfhound, below, run in the same way. Note how the hind legs pass outside the front legs in each case.

accord the dingo an important place in the family. The dingoes, in Australia, returned to wildness.

The dog ancestor of northern Europe and Asia lived on, alongside the wolf, during and after the Glacial Period. This dog, Studer suggests, was tamed—and from it was bred the race of larger domestic dogs such as the St. Bernard and Great Dane. Contemporary with this ancestor lived a dwarfed wild dog, from which the moorland dog was bred. From the moorland dog, which spread all over Europe, must be descended the Spitz, the pinscher, and the English terrier. It also played a part in the breeding of the dogs of the high North, the Lapland and Iceland dogs and the Finland bird dog.

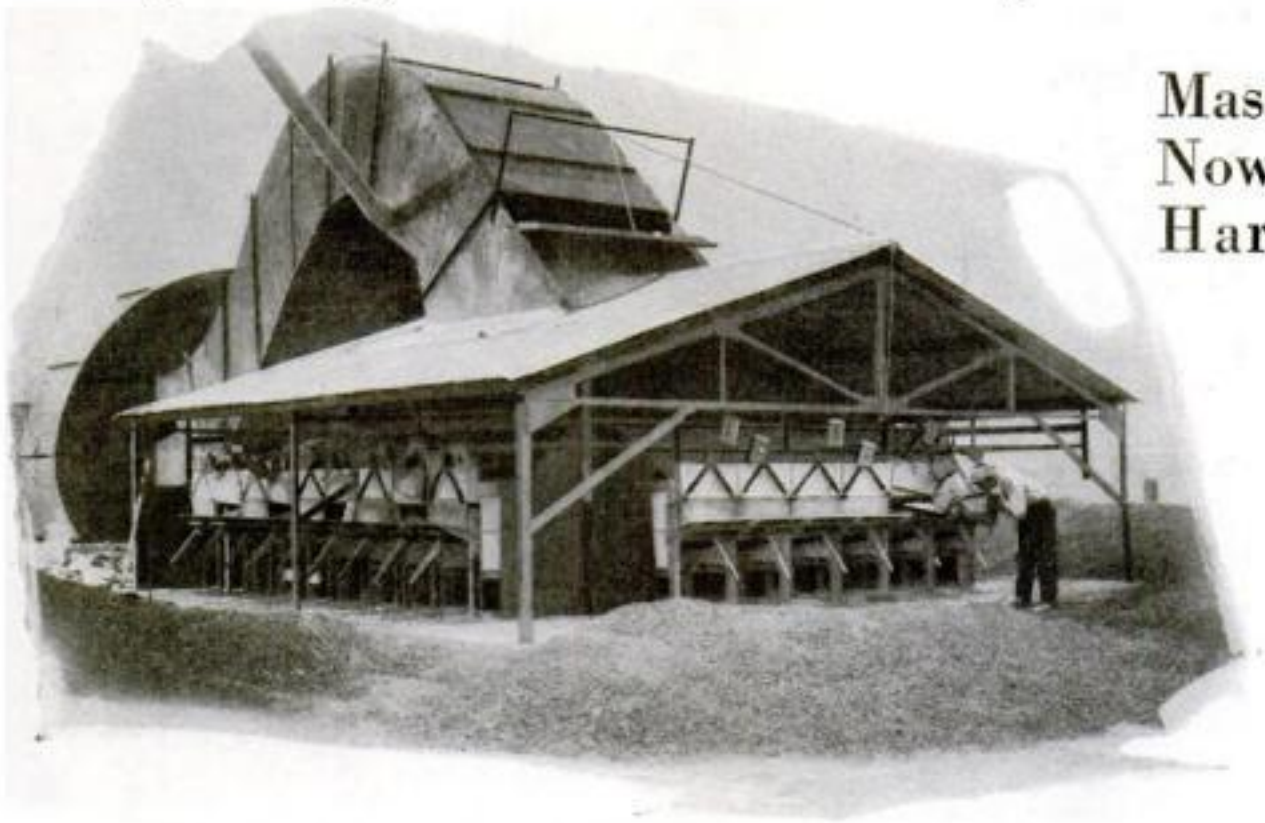
And what of the German shepherd dog, or "police dog" as he has been known since the war, perhaps the dog most talked of today? The bones of his ancestor, the Bronze Age dog, have been unearthed among relics of this period which date from 2500 to 1800 B. C., at Olmutz, in Moravia. A similar skeleton found on the estate of a Russian prince near Moscow confirms the fact that this dog came from the North, the region where the merciless struggle for existence produced the high dog types that spread over the world. Its skull proportions stamp it as the immediate ancestor of the present-day police dog.

The taming of this dog probably typifies that of most other dogs throughout history. He came during the night watches to the farms and villages, to scratch among the refuse heaps. Warm fireplaces lured him to human association, and food shared with the hungry dog banished his misgivings and made him glad to forsake the precarious life of the wilderness.

CONTRARY to popular opinion, the shepherd or police dog has not been crossed with the wolf, and has none of the qualities of such a mongrel. A dog-wolf mongrel is unreliable, sly, treacherous. An English enthusiast named Brooke, who kept and constantly observes all sorts of wild dogs—wolves, dingoes, hyenas—said he would rather deal with a wild old wolf than with a wolf mongrel. The German authority Stephanitz, after making many crossings, agrees. Fortunately the dog of the Bronze Age, the first comrade of the prehistoric shepherds, exists today in pure-bred descendants.

Today the shepherd dog is the center of attention among scientists who are anxious to find what part physiology plays in dog evolution. Dr. Charles R. Stockard, professor of anatomy at Cornell University, singles out the shepherd dog as the one most nearly resembling the normal wolf dog, or probable ancestor of most of the (Continued on page 144)

Drying Machinery Triples Crops



The heating plant. Here furnaces produce hot air at 300 degrees, and a twenty-foot blower sends it through the drying tunnel. Anthracite coal is the fuel used.

Mass Production on Farms Now Made Practicable by Harvesting Unripe Grain

By

JOHN E. LODGE

MACHINE methods applied to agriculture are growing three crops of grain a year where only one grew before. Already well past the experimental stage, a device that dries green crops artificially by coal fires and powerful ventilating fans is being used successfully on five large farms in the United States. It is said to permit mass production of agricultural products on a scale never before achieved.

When crops are cut green other crops may be planted immediately. The device that makes this possible, an artificial dryer for alfalfa, wheat, and other products, was invented by Arthur J. Mason, Chicago industrial engineer. It is said to make possible the harvesting of excellent hay in May and of cowpeas in November when conventional farming has long been through for the year.

Trucks deliver green cut crops to the drying machine. The alfalfa or other material is torn to individual strands and formed into a mattress nine feet wide and nearly a foot thick. It enters a drying tunnel 150 feet long. Hot air from twenty-four furnaces robs it of its moisture during the slow trip through. Then the cured, bright green mattress of hay is torn apart and shot by an air blast to the barn. One hour after the alfalfa is cut it is cured, ground to meal, and stored away.

Another link in the swift process is a fleet of mowing machines that cut the alfalfa, chop it into foot lengths, and deliver it to trucks moving alongside. One man drives the mower, and another the truck.

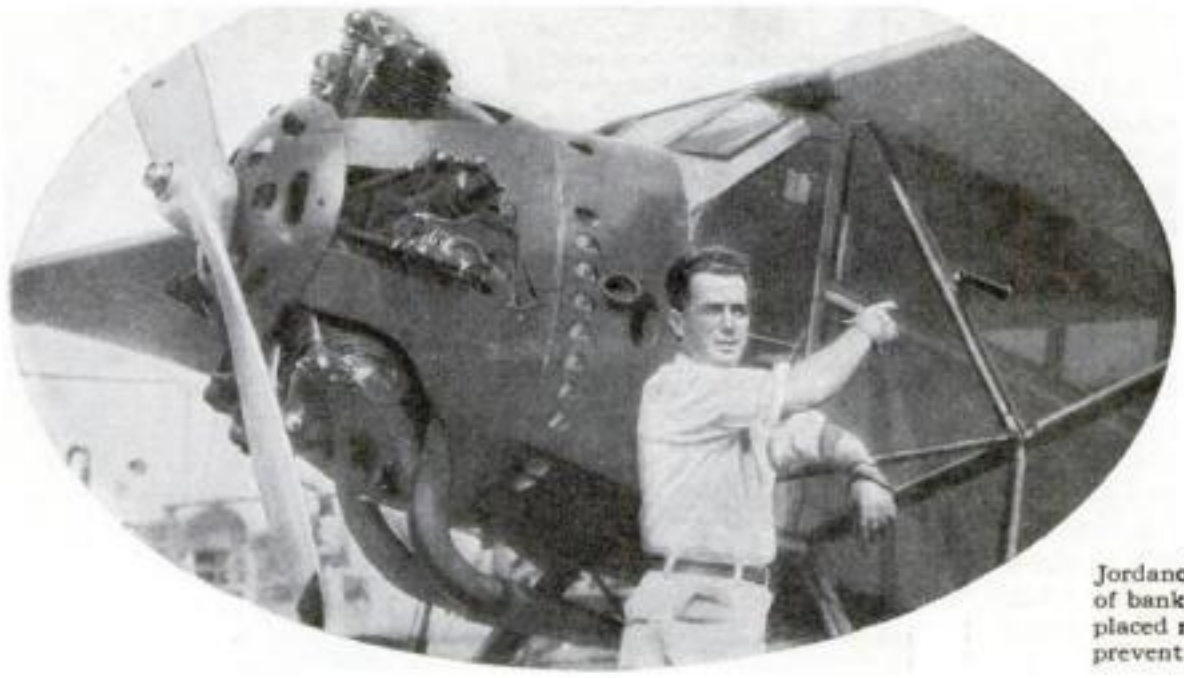
As a result of the drying process, the product is claimed actually to have an enhanced food value in flesh-building proteins and in nitrogen content, together with other elements of value to such animals as milk cows. Wheat, rye, oats, barley, and soy beans are among the crops handled, at the rate of two tons an hour. A thousand pounds of coal will dry a ton of the finished product.

Extensive use of the novel system might have other important consequences. By planting three crops a year, for example, the farmer might conquer the vexing problem of soil erosion. This erosion, due to heavy rains which fall upon open, plowed-up fields and carry away the soil, is estimated in Government figures to cost America one sixteenth of an inch of her best soil every year—threatening to denude it within a century. Planting three crops a year would bind together the soil and in this manner protect it from washouts.

HAVING passed the experimental stage, as first described in this magazine (P.S.M., Oct. '27, p. 32), the machine method has now been operated successfully on a commercial scale. Feed for a herd of 2,500 cows is dried by this machine at a large Plainsboro, N. J., dairy farm, where it has been in operation for three years. Last year another machine dried soy bean hay from April to September at a Thibodaux, La., farm, following this with native grasses in October, and it is scheduled to fill in the time to the next soy bean harvest with alfalfa. One Waco, Texas, farmer found it profitable to use the machine. Several other machines have been operated on a commercial scale by the inventor.

The drying plants can be operated 200 days a year, regardless of the weather, on a 600-acre tract, tripling its usual output. The system is not adapted to small farms, as one of at least 400 acres is required to keep it operating steadily from the first to the last cutting. However, a group of farmers could get together and rent or buy such a plant and use it profitably on a coöperative basis.

This machine receives green cut alfalfa from trucks, forms it into mattresses, and sends it into the drying tunnel. Above: A truck runs beside the mower gathering the harvest, which is cured in an hour.



Jordanoff points out how air tube of bank and turn indicator now is placed near engine for warmth, to prevent clogging by ice or snow.

Beating the Weather in the Air

What a Veteran Pilot Has Learned from Encounters with Storm and Fog During Sixteen Years of Flying

By ASSEN JORDANOFF

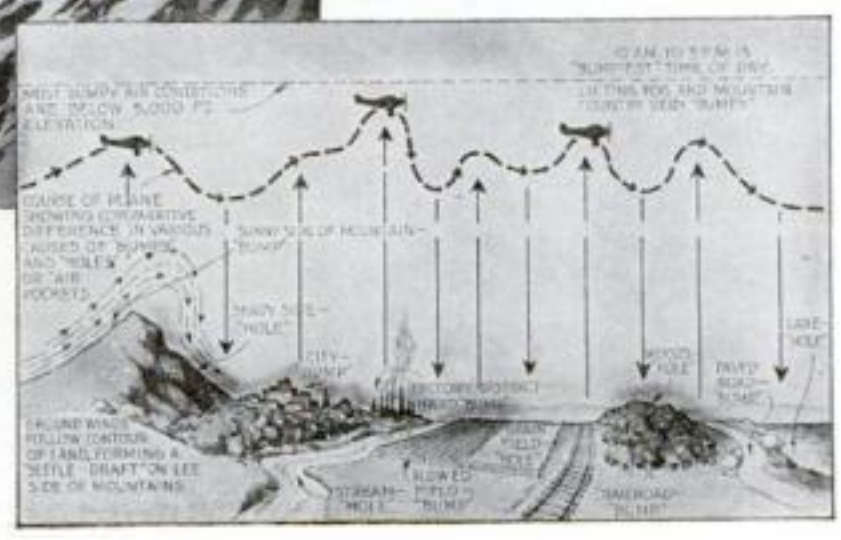
WHEN I think of flying weather at its worst, I think of a 9,000-foot plunge through darkness filled with ripping bullets of ice that I once experienced.

I was up with a photographer in a Bulgarian army plane during the war. We were ordered to take pictures of British movements behind the Saloniki lines. The sky was ugly. The ceiling was lower than the jagged cliffs of the neighboring mountains when we took off. At 10,000 feet, our Albatross nosed out into the sunshine. We saw shrapnel bursting in white puffs above the rolling layers of clouds. Gunners were aiming at us by the sound of the motor.

I dodged the gunfire, swerved into a saddle-shaped depression between two clouds, and—it happened. A gigantic down draft caught the ship and sucked it into the clouds. The stick jerked from my hand. The ship turned over and over, rearing and plunging as it fell. Completely out of control, it went down with screaming wires through clouds so black we could barely see a foot ahead of us. Rain and hail filled the darkness. The water struck as though shot from a fire hose and the white bullets of hail ripped along the fuselage and crashed against the wings.

Fighting for control of the ship, I crouched behind the windshield, at times plunging two miles a minute toward the crags below. We might strike and never see them. A queer thought flashed into my head. I wondered if I would know I was dead after we hit. Then a miracle happened. Like a cannon ball, the Albatross shot out of the clouds below the tops of the mountains. It was in a tight spiral, diving parallel to the mountain slope less than 100 feet away. Had it come out headed the other way, nothing could have saved us. The altimeter showed less than 1,000 feet when I got her leveled off. We had fallen nearly two miles. After I landed at the flying field, I found the trailing edge of one wing almost in shreds from the strain of the terrific dive and the pounding hail. Our faces were swollen and for days they were pitted, as though pock-marked, where the balls of ice had struck.

Around clouds there are always rising and falling air currents. A cloud is formed by a warm, moist current rising into cooler regions of the upper atmosphere. When a flyer passes under a large cloud on a hot day he gets a bump. Under all such clouds are strong rising currents. Glider flyers in Germany use them to soar for miles across country in a new sport they call "cloud flying." Starting from a hilltop, they glide to a place under a cloud and are carried upward by the column of rising air. Then they soar on to the next rising column, in this way progressing for long distances. Within the great mountainlike masses of a cumulus cloud, drifting in summer skies, there are rising currents under every "peak" and descending currents under every "valley." In passing through such a cloud, a ship is carried up and down like a roller coaster.



Above the lee slope of a mountain such as this a flyer often encounters a strong downward air current, or "settle-draft." The diagram at the right pictures the various sources of "bumps" in flying caused by rising currents of warm air, and of "holes" in the air produced by cool downward air currents.

A few years ago, two air mail pilots, flying through a storm over the mountains of western Pennsylvania, encountered the largest vertical air current so far measured: Both the westbound and the eastbound planes were thrown straight up for more than 1,500 feet. One of the flyers reported that he pointed the nose of his plane down and, with the air speed indicator showing 140 miles an hour, hovered without descending a foot. When he emerged at last from the rising column, it was to plunge into a down-current almost as violent.

THERE are four kinds of clouds—cirrus, high, featherlike, and usually in belts across the sky between 25,000 and 30,000 feet from the ground; nimbus, thick, formless, bringing rain, usually between 5,000 and 8,000 feet in the air; cumulus, mountainlike masses drifting below 5,000 feet; and stratus, low, horizontal sheets of lifted fog.

By studying the forms and actions of clouds, a flyer can learn much about the weather ahead. For instance, soft, delicate clouds indicate fine weather and light breezes. Heavy, "oily" clouds mean wind. Generally speaking, the softer the clouds look, the less wind there will be; the more "greasy," hard, and ragged they are, the stronger the wind. Another rule for everyday use is: the higher the clouds the finer the weather.

When high clouds cross the sky in a direction different from that of the ground wind and the lower clouds, it means a coming change of the surface winds to conform to the movement of the upper clouds. After clear weather, light streaks and patches of white clouds in the distance indicate a probable change of conditions. They gradually increase, followed by an overcast, murky sky that grows into cloudiness. Light, misty clouds forming or hanging around mountain tops should be watched closely. If they rise and dissipate, the weather will be clear. If they remain stationary, wind and rain are probable.

LAST August, I ferried a Stearman plane east from Wichita, Kansas. Three times in one afternoon I had to side-step thunderstorms; which, by the way, are most frequent on hot summer afternoons. I could see the approaching thunderheads far across the prairie. I would watch the direction of their progress, swing off my course to pass around them, and then cut back on my course behind the storm. One peculiarity of a thunderhead is that it is four or five times as long as it is wide. It advances like an airplane wing, long side foremost. The path of a thunderstorm is rarely more than forty or fifty miles across.

Incidentally, in flying through bad weather, the best rule I know for deciding whether to continue or to land is to look back occasionally. You know the sort of conditions you have flown through, and if the sky ahead looks no worse than the sky behind, it is a pretty good sign you will be able to get through.

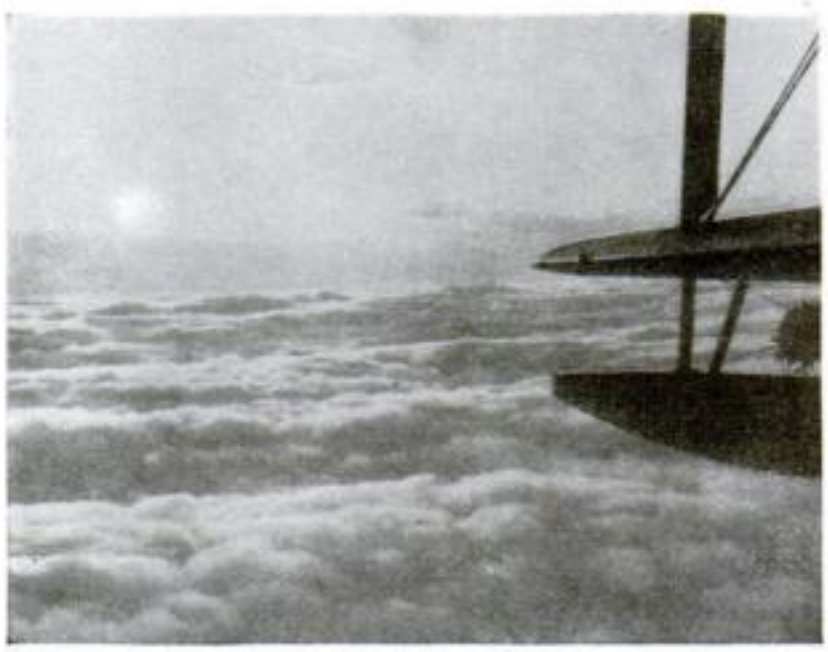
It rarely takes more than half an hour to fly through a thunderstorm, but those thirty minutes seem like hours. In pitch darkness, except for fearful streaks of lightning which sometimes hiss past the wings, the ship careens on boiling air. After one such experience, a pilot either side-steps a storm or lands before it strikes. The danger of being struck by lightning is too great, and the violent vertical currents menace the life of a plane.

These up and down currents, on a smaller scale, make the "bumps" and "holes" in the air. "Air pockets" and "holes in the air" are merely down currents. A ship strikes one and drops until the pilot levels off. Sometimes one wing dips suddenly. It has hit a down draft. Bumps are most frequent in the air up to five thousand feet, but they are found as high as fifteen thousand feet.

A large transport monoplane flying through the clouds. The drawing at the left shows various kinds of clouds and their average heights above the earth; also how rising and descending air currents within a cumulus cloud carry a plane or glider up and down like a roller coaster.

EARLY in the morning, bumps are close to the ground. By noon they rise to 2,000 or 3,000 feet. The four or five hours from ten in the morning to two or three in the afternoon are the bumpiest. In the morning, evening, and at night the air is smoothest. When fog begins to lift, the air is very bumpy until it all disappears. The same is true when dew or frost is evaporated by the sun. When patches of sunshine and shade are encountered on a hot day they mean a bumpy condition in the air.

Unless a pilot has his safety belt buckled, a bad bump may throw him against the stick, causing the ship to dive. I remember once flying with a student who forgot to slip the metal tongue of his safety belt catch under his belt loop. The tube of the Gosport helmet, through which the instructor speaks from the front cockpit, caught under the catch and flipped the belt loose. At 2,000 feet, we hit a terrific bump. The pupil sprawled to the front of his cockpit, knocking (Continued on page 148)

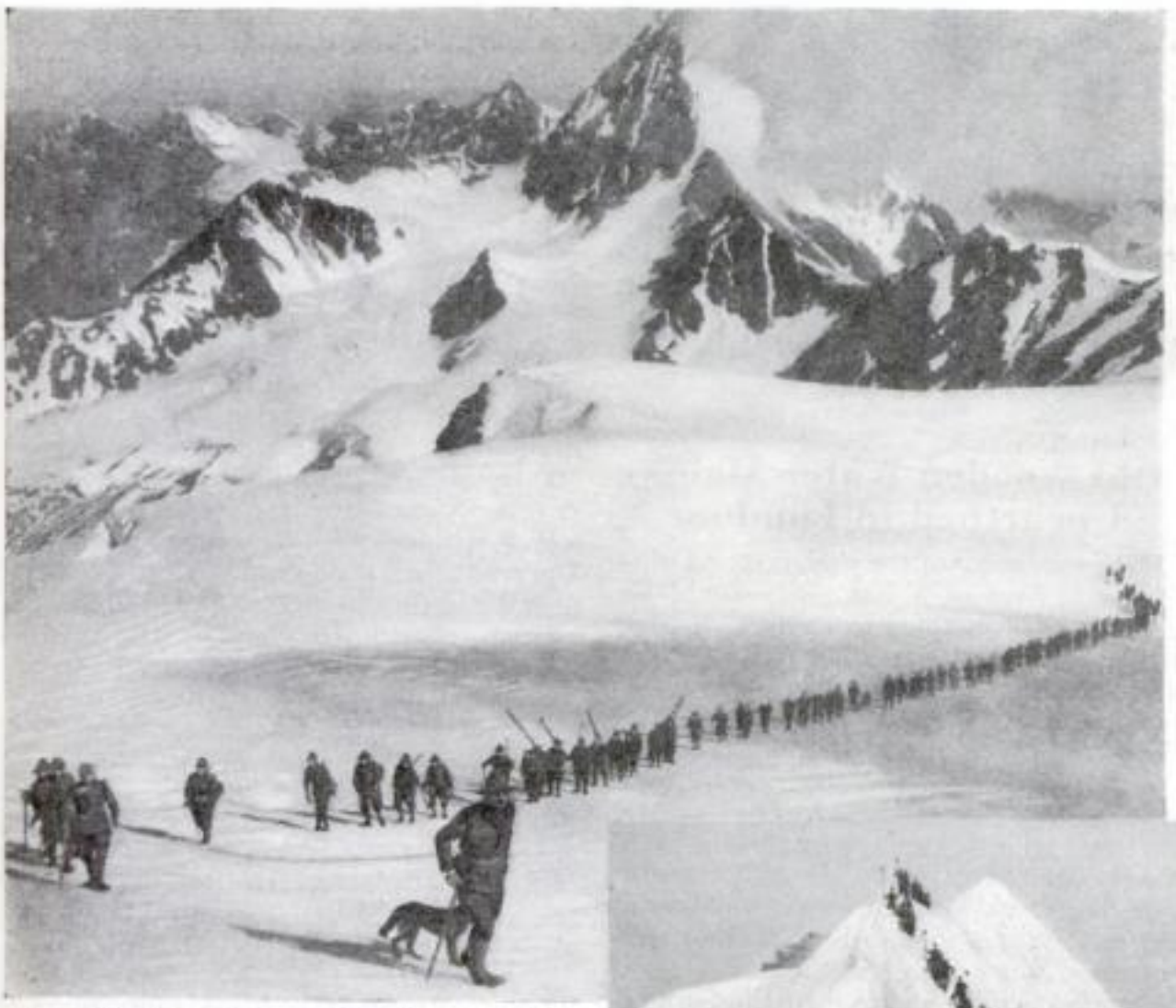


Sunset above the clouds—an unusual photograph taken from an airplane flying over a billowy sea which blanketed the earth.

NEXT month — "Twenty Years of Planes and Pilots." From his recollections and personal experiences as war bird, barnstormer, mail pilot, and flying instructor, Assen Jordanoff tells a picturesque story of aviation since its early days.

POPULAR SCIENCE SCRAPBOOK

News, pictures, and brief bits about unusual people, places, and things are gathered here from all parts of the world



An antlike file of Italian mountain troops crossing a lofty snow field during their mountain climb.

Italian Troops Scale the Alps Single File

TOILING along the snow-covered crags of the upper Alps, in antlike single file, hardy Italian troopers recently engaged in a spectacular mountain-scaling maneuver. Nearly a mile of marching men, tied together with long ropes as a precaution against falling over cliffs, wound up the slopes of the Bernina peak on the border of Italy and Switzerland.

At its summit, Bernina is more than two miles above the sea. Much of the long climb had to be made above the clouds. Smoked glasses protected the eyes of the troopers from the dazzling glare of the sunlight reflected from the lofty snow fields. At times, the men had to struggle through local storms and against the piercing winds of the mountainside. They carried alpenstocks to aid them.

The dangerous feat of scaling the 13,295-foot mountain is part of an annual maneuver by the northern troops of the Italian army to test endurance.

Mystery in New Blue Gem

BEAUTIFUL deep-blue gems of zircon, hitherto known only in brown, greenish, or yellow colors, recently appeared in American markets and puzzled jewelers. Now the mystery may be explained with the observation of Dr. George F. Kunz, New York jewel expert, that they may owe their color to the little known and only lately-discovered element hafnium.

Scaling Bernina's pinnacle, 13,295 feet high. The hardy soldiers were tied together with a series of long ropes.

This expert, first to recognize the stone as a new variety of the semiprecious material zircon and to name it "starlite," first set about tracking its source. All samples turned out to originate from a single place, near Chantaboon, Siam. Brown zircon crystals, he found, were heated with cyanide of potassium, a poisonous compound, in a crucible for several hours. When they came out some of them were of the peculiar shade of blue. These were the heavier varieties of zircon.

These very varieties, Dr. Kunz points out, are those that are known to contain the element hafnium in small quantities. He suspects therefore that the hafnium produces the color, which is brought out with the aid of the chemical treatment. Despite this handling, the gems are not considered artificial by jewelers; they are prized varieties of zircon. A five-carat stone of the new blue color, it is reported, sells for about $60.

The element hafnium, known only since 1923, was discovered by two Danish chemists and soon after was isolated in pure form from rare earths. Now it is known to be abundant enough to make up 1/200,000 part of the earth's crust, though commercial uses still await it.

Tells Why Mayan Prayers Brought the Rain

WHEN the ancient Mayas of Central America prayed for rain they got a quick reply. Their prayer was answered the same day it was offered, or very shortly after. This was not divine intervention, but a scientific coincidence of the seasons, according to Zelia Nuttall, famous expert on Central American history who recently addressed the Royal Anthropological Institute in London.

The Mayans conducted their annual ceremony of sun worship and prayer for rain on the first of two days in the year when the sun, in tropical parts of the earth, stands precisely overhead. These days correspond to the astronomer's equinoxes, well known harbingers of rain. The explanation of the downpour which followed the yearly prayer is purely physical, Nuttall declares. When the sun is directly overhead the ground is highly warmed. This heats the air next to the ground and causes warm, moist air to rise. In the upper air this moisture condenses to rain. The Mayans were versed in astronomy to a remarkable degree (P. S. M., Jan. '30, p. 22), but they failed to connect the natural sequence of the sun's position with their fervid prayers.

Men Win Race with Rats

FORTY-THREE white rats recently vied with twenty-three college students in threading a maze at the laboratory of R. W. Husband, psychologist of the University of Illinois, who is bent on comparing the intelligence of rats with that of men.

The rats were turned loose in the maze, with a food reward at the other end. The students were blindfolded and traced the

same maze pattern with their fingers. It was found that the students, though receiving no dinner as their reward, were quicker than the rats in winding their way through the maze. The rats erred most often in taking left turns persistently because one left turn happened to prove correct. The students, who were familiar with the idea that mazes turn right and left confusingly, tended to make the mistake of turning alternately to right and left too regularly.

Water Tanks Nest at Top of Eighty-Foot Tower

MAKING industrial buildings attractive has of recent years been one of the minor accomplishments of the engineering world; but nowhere, perhaps, have the results been so striking as in a unique building erected in Suffolk, England. At the top of this eighty-foot ferro-concrete tower, four huge circular tanks project from the corners like the bastions of some queer medieval castle.

The unique building is to be used for the manufacture of artificial silk. Above three floors of offices is a water-softening plant, where the water used in the manufacturing processes is first treated. It is then passed to the circular tanks for storage and distribution to all parts of the works.

Autumn Leaves Still Gay After Millions of Years

PALEOBOTANY, the science of flower fossils, has lately brought to light some unusual specimens, autumn leaves millions of years old imprinted on rock with the original colors retained. Dr. Ralph W. Chaney, paleobotanist of the Carnegie Institution in Washington, reports the finding of these curiosities in newly discovered fossil leaf beds of Wheeler County, central Oregon. He predicts the fossil flora found in this region will throw important light on numerous extinct plant species which must have formed a semitropical jungle in primeval Oregon.

How the autumn leaf fossils preserved their color is still a mystery, but it has been explained tentatively by the presence of minerals in the rock bed.

Old Wooden Water Mains Unearthed in London

THE evolution of the underground piping system of a large city could be partly traced in the Bloomsbury district of London, England, when replacement work was undertaken, following a series of gas main explosions, and a number of old wooden pipes used in bygone days for the transmission of the city's water and gas supplies was unearthed. The increase in the city's water consumption was clearly demonstrated by the difference in bore between these old wooden pipes and the steel mains installed in their place. Moreover, the decrease in the thickness of the material in proportion to the bore of the pipe, through the progressive stages of wood, iron, and steel conveyors, bears eloquent testimony to the ever-growing efficiency of engineering. Above are shown sections of the old wooden mains.

American Bald Eagle Is Near Extinction

IN A few years the American bald eagle will be seen only on coins and the coat of arms of the United States unless drastic action is taken to save these birds from extinction, according to W. Dewitt Miller, ornithologist of the American Museum of Natural History, New York City. In the last twelve years, about 70,000 bald eagles are said to have been slaughtered in Alaska alone.

When an emblem for the nation was being selected, Benjamin Franklin declared "the eagle is a bird of bad moral character." Most people agreed. Eagles were accused of stealing lambs and even of carrying away children. Recent studies made by Dr. Francis H. Herrick, of Western Reserve University, Ohio, have proved the bald-headed eagle guiltless of most of the crimes attributed to it.

The Old Traffic Problem

NEARLY 300 years before the automobile appeared, traffic congestion was already a problem. In London, a retired naval officer, named Bailey, had bought carriages previously used only by aristocrats, dressed the drivers in livery, and had begun carrying passengers. By 1635, fifteen years after the Pilgrims settled in America, London was already discussing the traffic problem. A proclamation resulted, barring semi-public vehicles from the streets.

Within the memory of people still living in England, there were only 2,000 public carriages in the largest city in the world. In the last few decades the coming of the taxicab and the omnibus has increased traffic many fold. Twenty-five million automobiles now run on the roads and streets in America alone. Widening thoroughfares and restricting parking are temporary steps in traffic control.

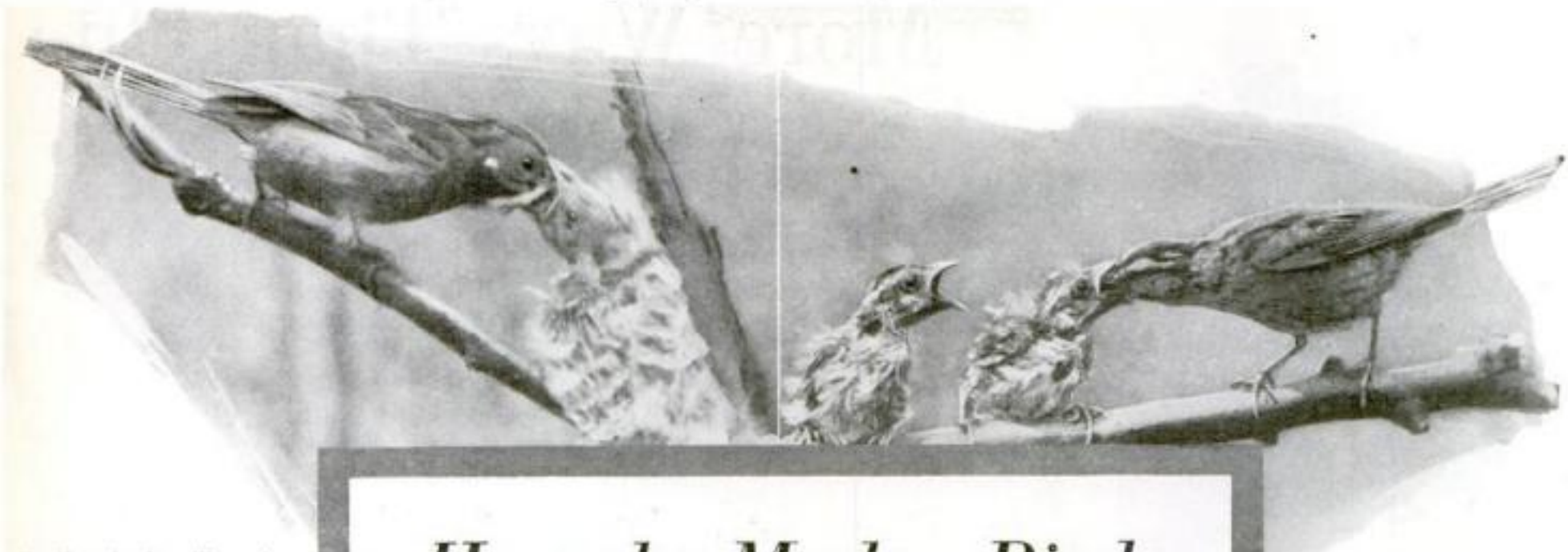
Builds Novel Telescope in His Back Yard

FOUR hundred individual lenses mounted on a wooden rack are being designed to provide a reflecting surface of 100 square feet in an unusual experiment in telescope construction by C. W. Woodworth, professor of entomology at the University of California. If it is completed and proves successful, it will be the largest reflector telescope in the world. At present the largest is the 100-inch reflector of Mount Wilson Observatory in California, made of one solid piece of glass.

With the aid of his novel instrument, Professor Woodworth expects to see and photograph the largest image ever made of a heavenly area. He has worked for two years on this telescope, grinding each of the 400 lenses with a special apparatus and fitting them together.

The instrument is being built in the professor's own back yard. On top of his barn, sixty feet away from the reflecting mirror, he has erected a scaffolding on which he will mount an eyepiece. Through this he will make his observations, picking up the image reflected by the united lenses.

Professor Woodworth shows how the eyepiece of his telescope will be mounted above his barn.



Feeding the foundling. A field sparrow, having unwittingly hatched a baby cowbird, dutifully plays the role of foster mother. Cowbirds are too lazy to build their own nests. Instead, they slyly deposit their eggs in the nests of other and smaller birds.

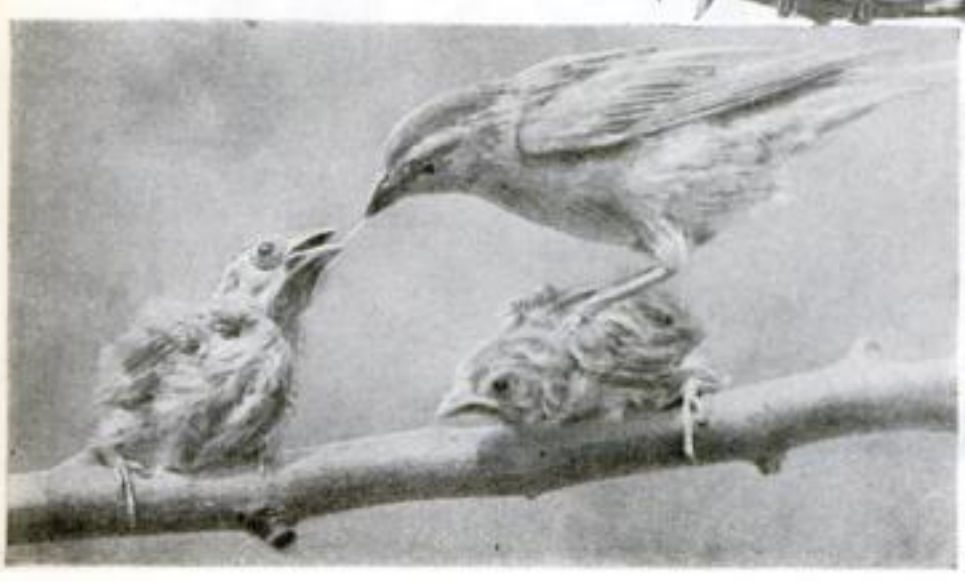
How the Mother Birds Feed Their Young

"Me next!" While one baby chipping sparrow gets a mouthful, the other clamors for its turn. So intent was the mother that she paid no attention to the photographer less than six feet away. These friendly birds, smallest of the sparrow tribe, line their nests with horsehair.

Left: "Close harmony" from the goldfinch quintet. When the mother arrived with food five heads popped up as far as necks would stretch. A long thread attached to the camera shutter made possible this remarkable close-up picture.

Below: The five goldfinches, having graduated from the nest at the right, are learning to fly. The goldfinch often is called the "wild canary" because of its color and its canarylike song.

Instead of carrying food in its bill, the parent flicker partially swallows it and pumps it down the throat of the young. "Golden-winged woodpecker" is one of its forty names.



Left: Treating 'em rough. The mother chipping sparrow uses one baby as a perch while she feeds the next in line. It was poor footing, and a second after the camera clicked, all three birds fell off.

More Ways Than One to Catch a Fish

Some Anglers Prefer Arrows, Spears, or Traps; Others Make the Birds Do the Work—Unusual Picture Stories of a Favorite Sport the World Over

A pelican and a cormorant serve this fisherman in place of hook, line, and sinker. When the birds return from fishing expeditions, he makes them disgorge their catch.

With a "bottomless bird cage" type of fish trap, this Filipino woman pokes around in shallow water until she can thrust it down over a fish. Then she reaches through the hole in the top and grabs the fish.

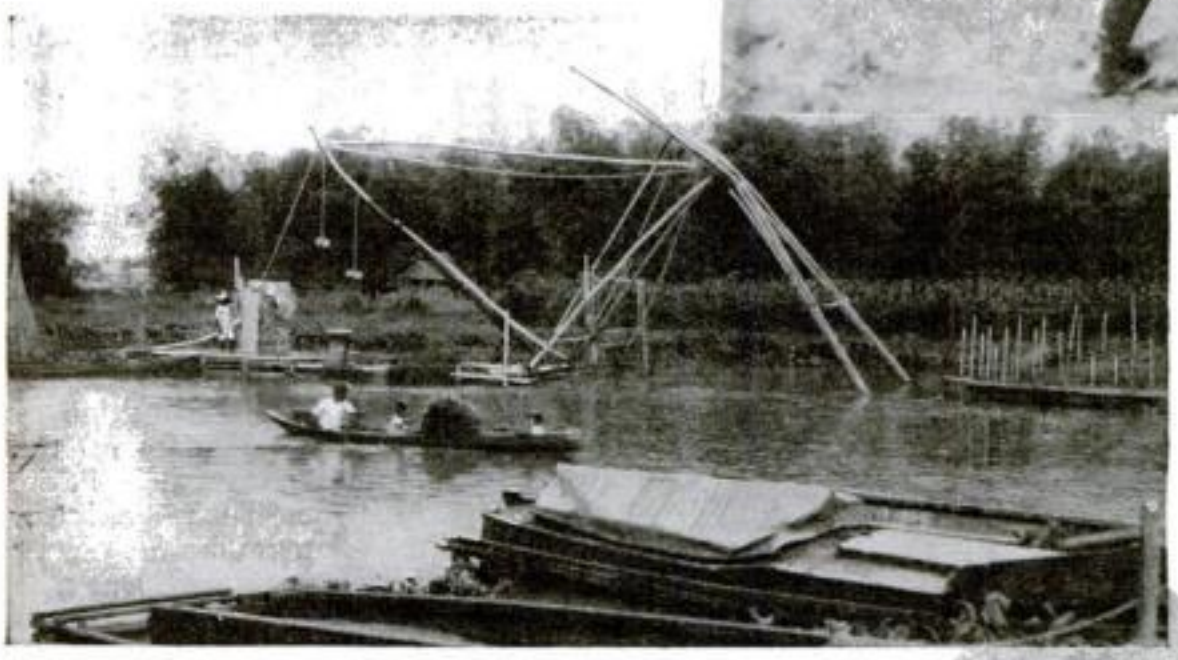
The blimp at the left served three Los Angeles flying anglers as a fishing craft. Ninety miles out they dropped their lines into the Pacific and landed 150 pounds of fish in a morning.

Since fish of the smelt family refuse to strike at a baited hook that is not in motion, German smelt fishermen call the wind to their aid, rigging windmills which spin the bait as they revolve.

At the height of the great yearly salmon run on the Columbia River in Oregon, these Indians at Celilo Falls line the bank with long hooked spears. They spear enough fish for a year's supply.

Here's a real idea for casting the line far out beyond the shallows. Working from the windward shore, these fishermen fill toy balloons with carbon dioxide gas which they have carried on their motorcycle. To the balloons they attach their lines with baited hooks and sinkers. The wind sweeps the balloons out, line and all.

"Watch Dad land a big one!" This unusual photograph shows how a Javanese father and son go fishing. Instead of hook and line, they use a bow and a long, three-pointed arrow. Wading out to a reef projecting from the water, they watch for a fish to come within range—and the arrow speeds to its mark. This sort of fishing is real sport, for it requires keen eyes and skillful marksmanship.



One of the great fish traps which may be seen along the upper Pasig River on the island of Luzon in the Philippines. The fish are caught in large dip nets suspended from a supporting structure of long bamboo poles. The fisherman, standing on a small dock projecting from shore, lowers and raises the heavy nets by means of ropes aided by counterweights.

Many South Sea Islanders prefer the throw-net for fishing. In the picture at the right, two Chamerros, natives of Guam, in the Mariana Islands, demonstrate their method of casting. Carrying small nets, folded and weighted, they wade out from shore. When one spots a school of fish, he quickly casts his net, outspread, somewhat as a cowboy throws a lasso. In this sport the natives develop surprising skill.

"The Most Repulsive Fish in the World"

Puzzle: find the stonefish. Where the four white marginal lines would meet, if extended, the creature will be discovered.

LURKING on the sea bed of the Great Barrier Reef, off Queensland, Australia, and so shaped and colored as to be almost indistinguishable from its surroundings of horseshoe clams, knobby corals, and algae-covered stones, a fine specimen of the "stonefish," called the world's most repulsive fish, was discovered recently by G. P. Whitley and W. Boardman, two scientists of the Australian Museum.

With its heavy, jagged fins, the fish resembles a rough-hewn, winged cornucopia. Instead of scuttling away at the scientists' approach, the creature remained absolutely motionless, while they took the photograph reproduced above. Then they prodded it with a stick, and it instantly raised three poisonous spines along its back. Its skull-like head was distorted into a series of bumps and hollows of a lemon-yellow color, and pock-marked with gray. The spines, too, were yellowish, with their covering puckered into fronds and frills that completely disguised their poison bags and needle points. Carefully the men netted the strange fish and carried it home at arm's length. In captivity it died.

The stonefish relies upon its spines, armed with their deadly poison, to protect it from all enemies, which explains why this specimen did not dart away at the scientists' appearance. Occasionally the poison has a fatal effect upon its victims. But one victim—a fisherman who had a finger scratched by one of these spines—recovered after much pain. For fifteen hours after the scratch, he told the scientists, he suffered intense agony and could get no relief from either doctors or herbalists. At times it felt as though someone were twisting each of his vertebrae separately.

The hideous face of the stonefish captured from the hiding place shown in upper photo.

Germs in Wound 11 Years

A GERM colony which took up lodging in the shoulder of a British Tommy when he was wounded in battle eleven years ago was recently found to be still alive, according to the report of the operation which brought it to light, made by Dr. R. J. V. Pulvertaft of St. Thomas' Hospital, London.

That a colony of bacteria, organisms only a few hundred-millionths of a centimeter in diameter, should demonstrate the power to hold out to such a hearty old age is a remarkable fact of biology. The germs had to battle against not only the resistance of the soldier's body, but also a serum which was injected at the time of his first operation at the front in 1918.

Some months ago the soldier complained of pain in the shoulder. Surgeon Pulvertaft operated and discovered a shell fragment which had been missed before, surrounded by the hardy microbes which had regained their vitality and started to make trouble again.

Ice Crystals Ages Old

IN CAVES in southwestern France water crystals have been found which are estimated to date back to prehistoric times. They were discovered in the "Cave of the Sister of the Falls" by archeologists who were exploring for traces of primitive men, and proved to be perfect water crystals, probably the largest ever found. Some were about four inches across and an inch thick. Solid natural ice or artificial ice seldom contains perfect crystals. To find them one must examine snowflakes or else the "frost pictures" which appear on window panes in extremely cold weather.

The formation of the unusual ice crystals in the French cave has been attributed to the remarkably constant conditions of moisture and freezing temperature which prevail in the cave. If a chemist were to make similar crystals of salt or sugar in his laboratory he would have to have similar constant conditions. But in the case of the water crystals Nature did the work in her own laboratory without a flaw long before man's laboratories were even conceived.

Twenty-Foot Water Wheel

A 57,000-horsepower water wheel, said to be the biggest ever built in the United States, is nearing completion at a Newport News, Va., shipbuilding yard. It is America's bid to capture supremacy in the building of the great rotors, of which the world's largest are those of 70,000 horsepower at Niagara. Hitherto large water wheels usually have been imported from Europe.

When completed, the new wheel, twenty feet in diameter and weighing 150 tons, will be installed in a 100,000-horsepower hydroelectric plant at Spiers Falls, N. Y.

Aluminum Playing Cards

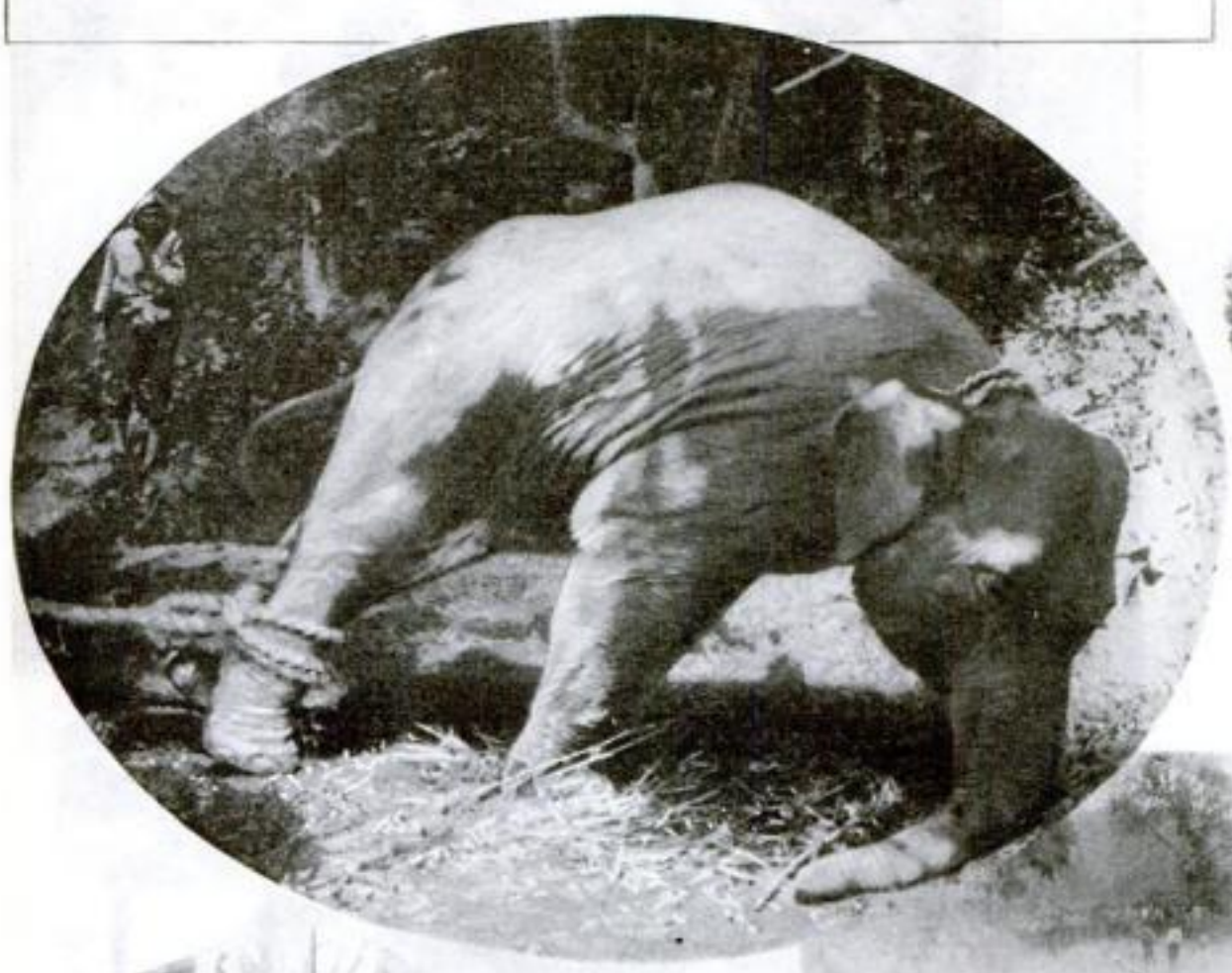
PLAYING cards made of aluminum, with colored faces and backs, are the newest thing for a game of bridge. They look and feel like ordinary cards, except that they are a little heavier. On the beach or porch, the cards will not blow away, and they are handy for the camper, too. If soiled or sticky, they can easily be washed.

Giant Mushroom as Large as a Hatbox

THE historic woods of Fontainebleau, France, have gained added fame from their ability to produce giant specimens of fungus. In the recent exposition of mushrooms and like growths in the Muséum d'Histoire Naturelle, Paris, France, appeared one such specimen, illustrated in the photograph. Some idea of the huge size of this growth may be gained by comparing it with the human hand resting upon the top of the dead wood to which the fungus is attached.

This huge mushroom, picked at Fontainebleau, would make a meal. Compare it with the hand.

Roping Wild Elephants in the Jungles of India



A futile fight against the rope that holds him. These wild Asiatic elephants become dangerous only when disturbed or attacked. Then they charge and seek to trample their foes to death.

Rounding up a herd of wild elephants—the climax of the hunt. The animals travel in "family parties" numbering from ten to fifty, or occasionally even 100 individuals. Each herd is led by a female.

MORE exciting than a Wild West rodeo, and more perilous, is a wild elephant hunt in the hill forests of India, as pictured here in close-range photographs. Decoyed by tame elephants, the angry, trumpeting beasts are rounded up in herds, roped with enormous "lassos," and captured alive. The stout ropes are made of seasoned jute by natives. One of these tethers weighs as much as 500 pounds. The photo in the oval above shows a captured elephant exerting the last bit of its strength in a vain effort to escape. The young tusker in the picture immediately above has become entangled in the heavy rope during the struggle. A full grown male stands about ten feet high.

Subdued and roped together, these wild elephants are enjoying their first bath in captivity. The Indian elephants require plenty of shade and water, and no animals enjoy a bath more thoroughly. They are good swimmers and, by means of their trunks, can breathe when their entire bodies are beneath the surface.

New Devices for the Home

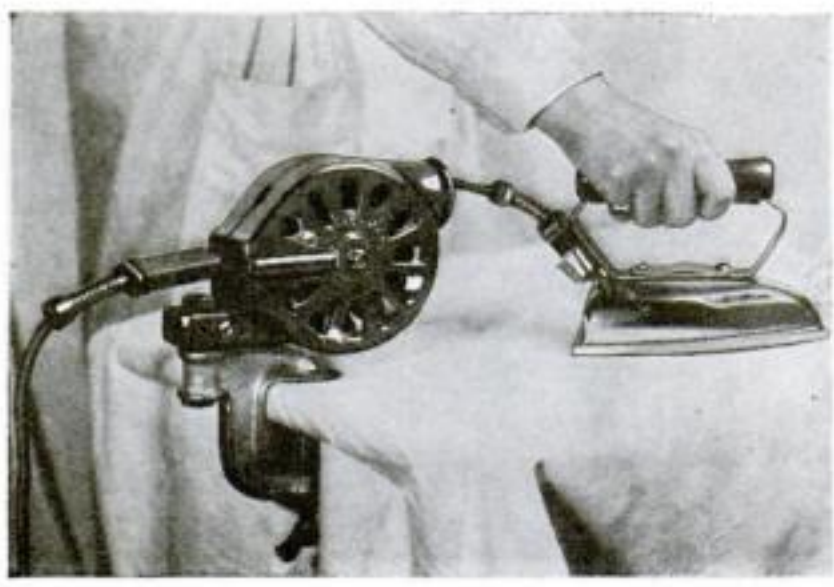
To save the hands, these metal "fingers" hold steel wool, dishrags, or polishing cloths. A sliding metal plate serves as a catch to seize the cloth or wool firmly.

Tray and serving table combined. Carried into the room, the tray's legs drop at the touch of a button.

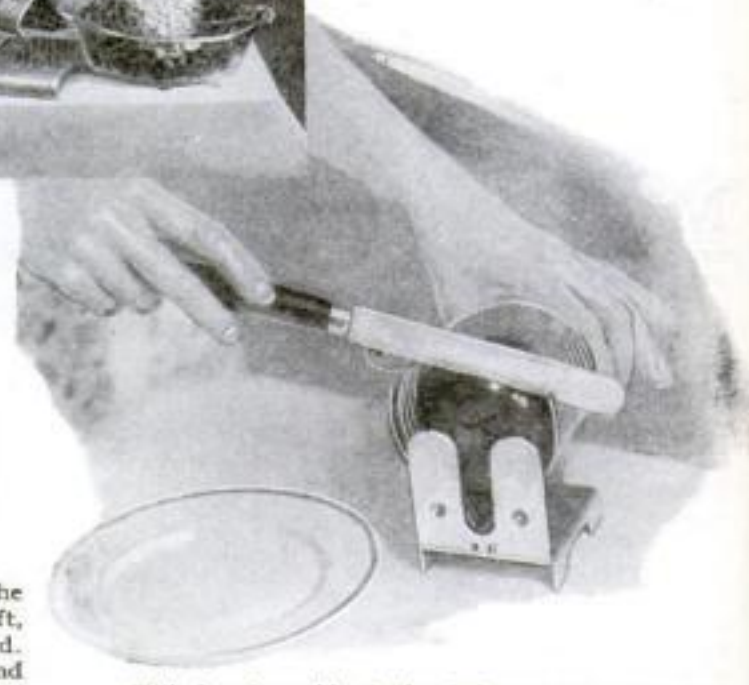
Built as a table, this electric heater warms a chilly room. Warm air, circulated by a fan beneath the table top, is shot out sideways in every direction through a narrow crack encircling the table just beneath the top. Switches provide much or little heat as desired.

Slit three edges of a cereal box cover, snap on this special clip, and the result is a container that closes tight to guard against spilling and to exclude dust. It is useful also on other boxes.

Salads are made more inviting, vegetables more appetizing, by a new set of three shredders—fine, coarse, and smooth. The set nests to occupy small space in a drawer. The fine shredder is in use.



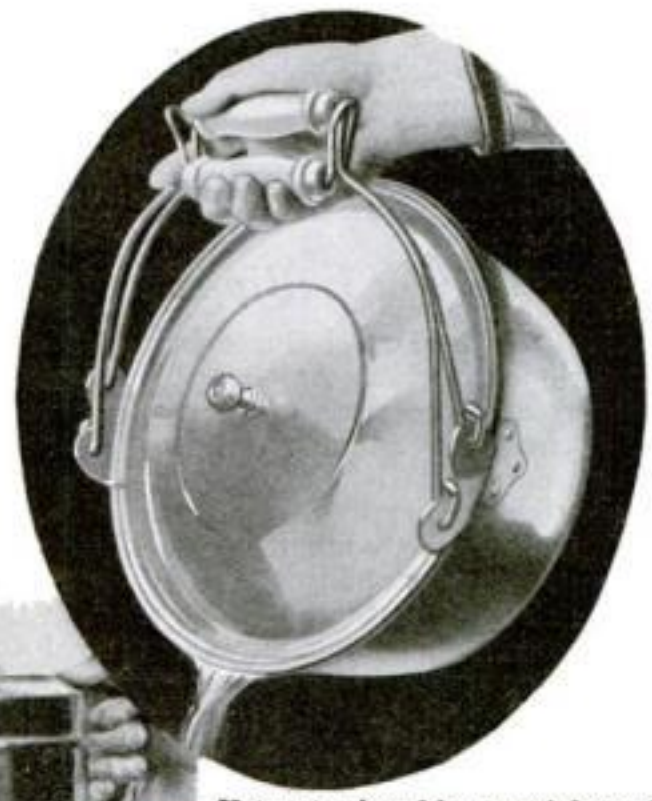
The iron cord is kept out of the way by a new reel, at the left, that clamps to the ironing board. The cord is drawn out easily, and firm gentle tension reels it back into the holder. The reel swivels, turning either way so as to follow the direction of the iron.



This handy guide device helps to cut a tomato into neat slices of even thickness. Curved prongs guide the knife and keep it from slipping. There are no spoiled slices to be wasted.

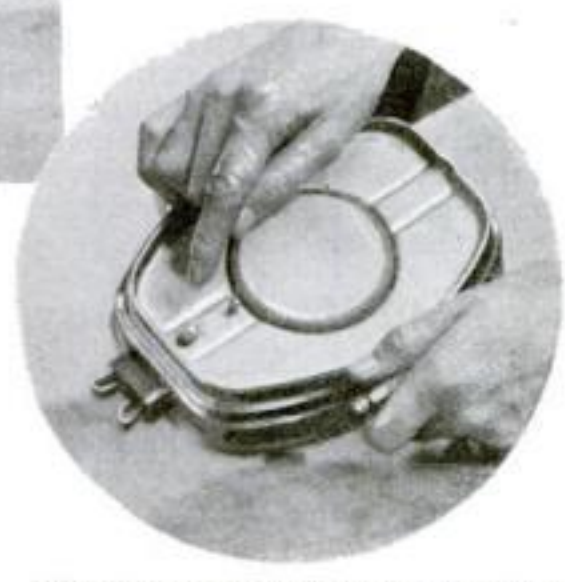
A rain-soaked overcoat or an evening's wash may be dried with equal ease in this new home electric dryer. A fan at the top forces air downward over a red-hot coil, creating a warm blast.

An auxiliary electric heater for extremely cold weather is contained in a cabinet which slips right over the steam radiator.



Hot water is safely poured from this novel kettle. Simply squeezing the two handles together tilts the pot, locks the lid, and allows the water to escape from the lip. The tight lid keeps steam from the hands.

A comfortable armchair by day (above) is transformed by one simple motion into this single bed for the unexpected overnight guest. Deep coil springs support the mattress which fits inside the chair when closed. The inventor declares the bed will not tip over.



When the coffee is done, a new electric drip percolator shuts itself off. It is made in two parts, with the heating element in the base. Percolating starts when the top is set on the base as shown in the upper picture. Above is a view of the base, the finger pointing to the contact which starts the percolating when the top is placed upon it. One advantage is that the top, when removed, can be washed without danger of short-circuiting an electric connection.

Popular Science
MONTHLY

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Is Aviation Falling Behind?

RECENTLY the Daniel Guggenheim Safe Aircraft Contest came to a close. Any hope of its being a "contest" in any accepted sense of the word faded long before the end. An airplane automatically received the $100,000 award because it was the only one successfully to complete the eighteen required tests for safeness.

These requirements were admittedly difficult, and all credit is due the winner for its ability to satisfy them. Yet the disturbing fact remains that there were no finals in the competition, simply because no other airplane entered could do it. The record of the competition is disheartening; twenty-seven entries promised; fifteen actually entered; nine remaining after withdrawals; three remaining after the preliminary tests, and only one that could pass them all. Two of the "safe" airplanes crashed.

This is an alarming record. It confirms what keen observers have been declaring—that in response to the enthusiasm developed by Lindbergh's Paris flight, manufacturers have been turning out airplanes in quantity along conventional lines, rather than pausing to experiment extensively with radical designs that might lead to greater safety. This opinion is shared by at least one airplane manufacturer, who now plans an extensive research program to develop new aircraft types. His action is well taken. It is high time that makers of aircraft discard the plan of letting well enough alone and catch up with the pioneering research spirit now demonstrated by other great American industries.

Good Memory—Easy as "Pi"

THE recently reported memory aid of Sir James H. Jeans, British astronomer, for recalling a precise value of "pi"—the ratio of a circle's circumference to its diameter—calls to mind more than one method of jogging up a wayward mind. Sir James is the author, it may be explained, of the edifying sentence, "How I want a drink, alcoholic of course, after the heavy chapters involving quantum mechanics!" The number of letters in each word of this sentence helps his students, he says—and possibly Sir James himself, who knows?—to recall the value of *pi* to the fourteenth decimal place, which is 3.14159265358979.

Absent-minded pedants, and students too, profit by similar tricks. The chemical formula of borax, $Na_2B_4O_7$, is still remembered by a former chemist, who has long since abandoned that pursuit for other fields, because his old-time professor pointed out that the "N-A-two" came "B-fore" the "O-seven." It has a lyrical ring to it.

And there was the ingenious college student who memorized his chemistry laboratory procedure by putting it into rhyme. Of his verse only this fragment remains:

"To obtain a precipitate, testing for lead,
The solution is neutral at best;
For if acid dichromate is present, instead,
You will get a less delicate test."

Thus the "Thirty days hath September" kind of memory-jogger has its place in science, too. And, after all, why not?

Next—Built-In Radio

IT IS rumored that various forms of so-called automatic tuning will be featured in next year's radio receivers. This seems logical, considering that there isn't much room left for improvements in tone quality, volume, sensitiveness, and the other qualities most desired in a set. Indeed, the radio receiver may eventually be classed with other mechanical apparatus around the house that now perform their valuable functions sight unseen.

The old-fashioned parlor stove has been banished by the far more efficient cellar heating plant. The craze for open-work plumbing is giving way to the demand for built-in bathtubs. Even the radiators must hide their homely features under fancy grill work screens.

Perhaps the radio of the future will become a simple enameled box to be installed, like other household machinery, in the cellar, attic, or an out-of-the-way closet. The dynamic speaker, or some possible successor, may become a regular part of the living room wall construction.

A Great Air Sport

"A MILLION glider pilots by 1935." That is the aim of the National Glider Association, recently expressed by its honorary president and founder, Edward S. Evans. Gliders cradled the earliest airmen. They produced the airplane. Now they are offering sky-minded 1930 Americans an opportunity to get into the air, enjoy the thrill of birdlike flight, and grasp the rudiments of plane piloting with a minimum of risk and expense.

Two hundred thousand enthusiasts have joined soaring clubs in Germany. We predict that a far greater number will be flying engineless planes in this country within the next few years. The radio, the small motor boat, the automobile, began with a handful of devotees, and the number of their users has grown to millions. The thousand members of the thirty-two gliding clubs affiliated with the National Glider Association are pioneers in a sport which will soon be familiar in all parts of the country.

POPULAR SCIENCE MONTHLY, through a series of articles commencing in this issue, hopes to stimulate greater interest in this most attractive of air sports.

They Are Saying—

"HALF of the total work of the world is done in the United States."—Dr. Thomas T. Read, Professor of Mining, Columbia University.

"Speech in the theater has felt the influence of the telegraph, the telephone, and the typewriter. The influence of all our time-saving, distance-killing devices is evident in most of the speech, staccato and brief, that I overhear today."—Professor George Pierce Baker, head of Yale University Dramatic Department.

"The most valuable stone in the world today is the emerald of pure water."—Dr. George F. Kunz, New York gem expert.

"There is no such thing as a pure race anywhere. Even in Scandinavia, supposed home of the Nordics, not fifty percent of the people can be classed as Nordics."—Dr. Fay-Cooper Cole, Professor of Anthropology, University of Chicago.

"The time is not far distant when meats will be cut up into steaks, chops, roasts, and the like at the central meat-packing plants, then frozen, packaged, and distributed through grocery chains, independent grocers, and other outlets in the same handy way that groceries now are sold."—Charles C. Small, President, American Ice Company.

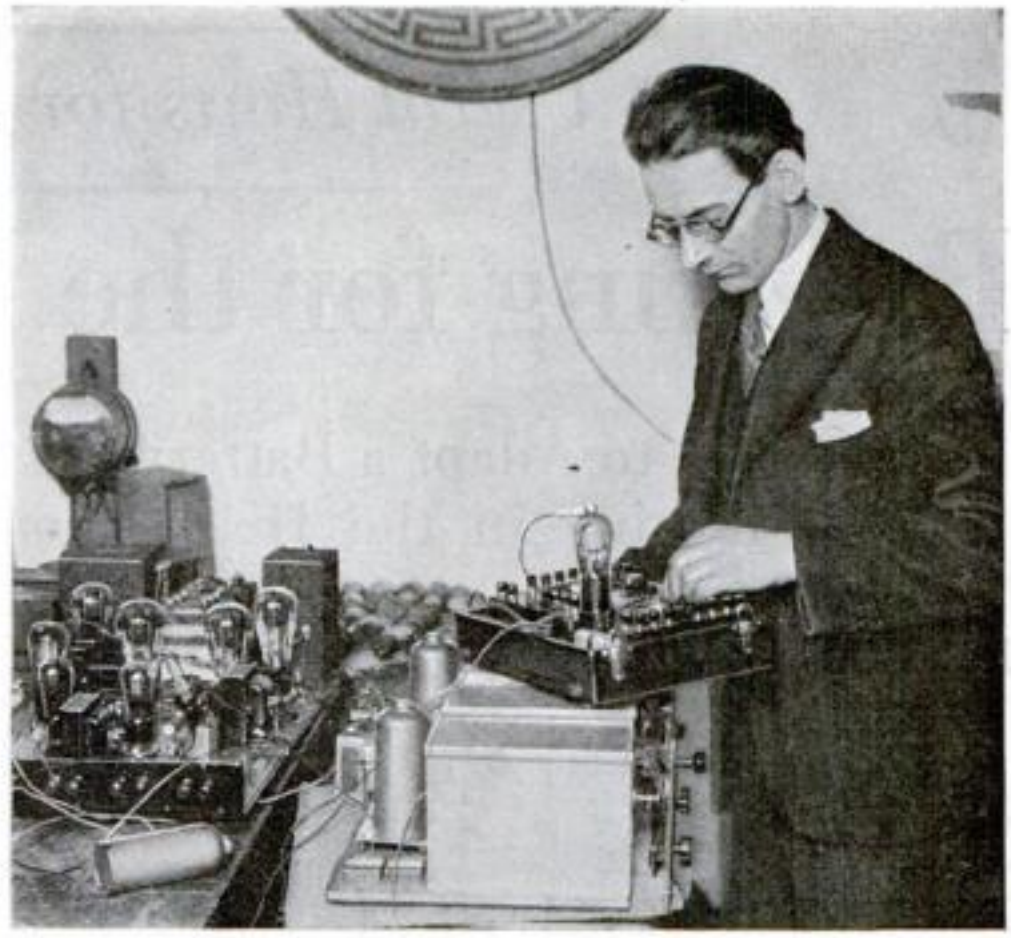
"The year has been gratifyingly and unexpectedly rich in progress."—Dr. Charles G. Abbot, Secretary, Smithsonian Institution.

How to Control Screen Grid

Experiments on the POPULAR SCIENCE MONTHLY Distance Getter show ways to get rid of cross modulation and improve selectivity of the receiver

By

ALFRED P. LANE



Experimenting with the Screen Grid Distance Getter in the radio laboratory of the Popular Science Institute to improve selectivity.

ENGINEERS hailed the appearance of A. C. type screen grid tubes with enthusiasm. The new tubes, they said, would make radio receivers easier to design and more efficient in operation. Their predictions have largely been fulfilled. For any given degree of sensitiveness it is easier and simpler to employ a circuit using screen grid tubes.

In one respect, however, the screen grid tube has brought a distinctly new trouble. A peculiarity of the new tube is that its amplification depends on the voltage applied to the screen grid. As the voltage is reduced, so is the effectiveness of the tube. Engineers believed that this feature would prove to be the long sought solution of the problem of controlling the volume of a full electric set. Consequently varying the voltage applied to the screen grid now is the popular method of controlling volume on a screen grid set.

Unfortunately, however, when a sensitive screen grid set is used near several broadcasting stations this method results in apparent lack of selectivity. Stations many degrees apart on the dial jumble together, and the set owner naturally blames the new screen grid tubes.

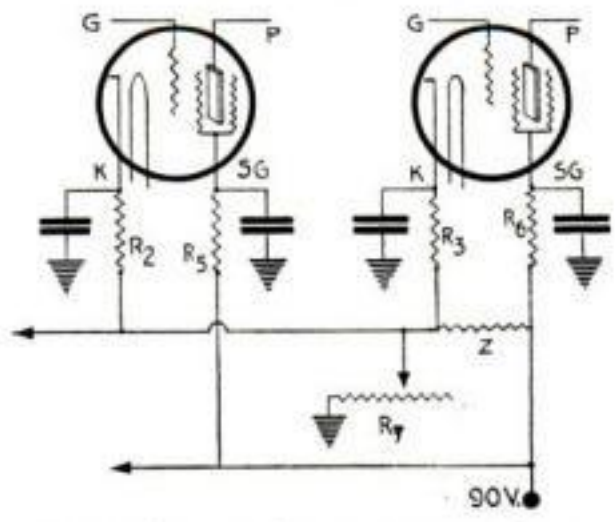
Experiments by the engineering staff of the Popular Science Institute, working on our Screen Grid Distance Getter, have resulted in locating the cause of the trouble and in working out a remedy.

When a sensitive screen grid receiver is subjected to powerful local signals from two or more stations, the volume control must be turned down so far that the screen grid of the tube actually operates at a very low potential, resulting in serious reduction in the control grid bias. Under such conditions cross modulation takes place.

THE common method of designing a radio circuit is to use an antenna coil closely coupled to the grid coil of the first tube. The antenna circuit is left untuned and, in consequence, it is literally alive with the carrier waves of many different broadcasting stations. When the screen grid voltage is reduced too low there is a grid current flow owing to the lower C bias, and the effect is to give the tube a rectifying action. Each carrier wave, of course, carries its own voice modulation that represents the broadcasting at that particular station, and the rectifying action produces the cross modulation. This means that the modulation of one carrier wave is impressed on the other. The result is that no matter how many tuned stages are used, the two powerful stations cannot thereafter be separated because each carries a definite impression of the modulation of the other wave.

There is a definite way by which the radio set owner can distinguish between cross modulation and ordinary lack of selectivity. If cross modulation is taking place, both the station that is tuned in and the interfering station will become weaker as the dial is moved away from the tuned-in station's wave length; and perhaps both will disappear altogether before the pointer reaches the division on the scale at which the interfering station normally is heard. If the trouble were true lack of selectivity the interfering station would sound louder as the station to which the dial was tuned faded away.

The solution of the problem, as worked out in the Popular Science Institute radio laboratory, is to abandon the present method of controlling the screen grid tube and substitute the following method. Instead of applying a varying voltage to the screen grid, this element of the tube is maintained continuously at the rated working voltage which, in the case of the UY-224, is ninety volts. Then the volume is controlled by changing the bias applied to the control grid of the tube. The circuit, shown in the diagram, should allow the control grid bias to be increased from minus three volts, the rated working voltage of the latest UY-224 tube, up to ten or even twenty volts, depending on value of resistance *Z*. This method eliminates the possibility of grid current flow and makes cross modulation impossible. For the set owner the apparent result is to improve the selectivity.



Wiring diagram of improved screen grid volume control, which prevents cross modulation.

There is a possible disadvantage of any type of volume control that works by changing the plate current of the tubes. If used on an extremely sensitive set in a locality close to a number of broadcasting stations, and if the set is connected to a long outdoor antenna, there may be signs of distortion on the most powerful local stations when the volume is turned way down. The remedy is to use two antennas —a short one for local reception and a long one for distant stations a few degrees on the dial from the local station.

Builders of the Screen Grid Distance Getter described in the September, 1929, number of POPULAR SCIENCE MONTHLY, and now available in Blueprint 109, will find this diagram particularly useful in revising the circuit to conform to the new method. Of the second two tubes shown in the present diagram the first is arranged in exactly the same way as before, connections being made to the two wires indicated by arrows. Resistances *R2*, *R5*, *R3*, and *R6* are of the same values as in the original circuit. *R7* also is the same 10,000-ohm potentiometer. *Z* should be a good fixed resistance of any value from 50,000 to 100,000 ohms. Of course, only the wires involved in the new method of control are shown in this diagram. All other wires remain as in Blueprint 109.

By this new method of control a constant but small flow of current going through resistance *Z* produces a drop in potential as it flows through the portion of *R7* that is included in the circuit, and by moving the contact of *R7*, the bias of the control grid *G* can be set at any value from minus two and a half to three volts to minus six or seven volts.

Useful Hints for the Radio Fan

Rewiring for the New A. C. Tubes

How to Adapt a Battery Set to Use 227 Heater Tubes; Plugging in the Headphones for Distance Reception

THE simplest method of rewiring an old battery set for A. C. operation is to use type 227 heater A. C. tubes in all sockets except that of the last audio stage, in which a type 171A power tube should be used. In POPULAR SCIENCE MONTHLY for February, 1929, on page 65, was outlined a method of rewiring a battery set, using 226, 227, and 171A tubes. Now that the 227 tube has been so greatly improved, however, more satisfactory results will be obtained by using these tubes in place of the 226 tubes formerly used in the radio-frequency and first audio stages. The fact that the 227 tube has less interelement capacity and a somewhat higher amplification factor insures better results with this tube in the radio-frequency stages, particularly in sets of the neutrodyne type. Also, the 227 tube is more easily balanced than the type 226 and operates with less hum in the first audio stage.

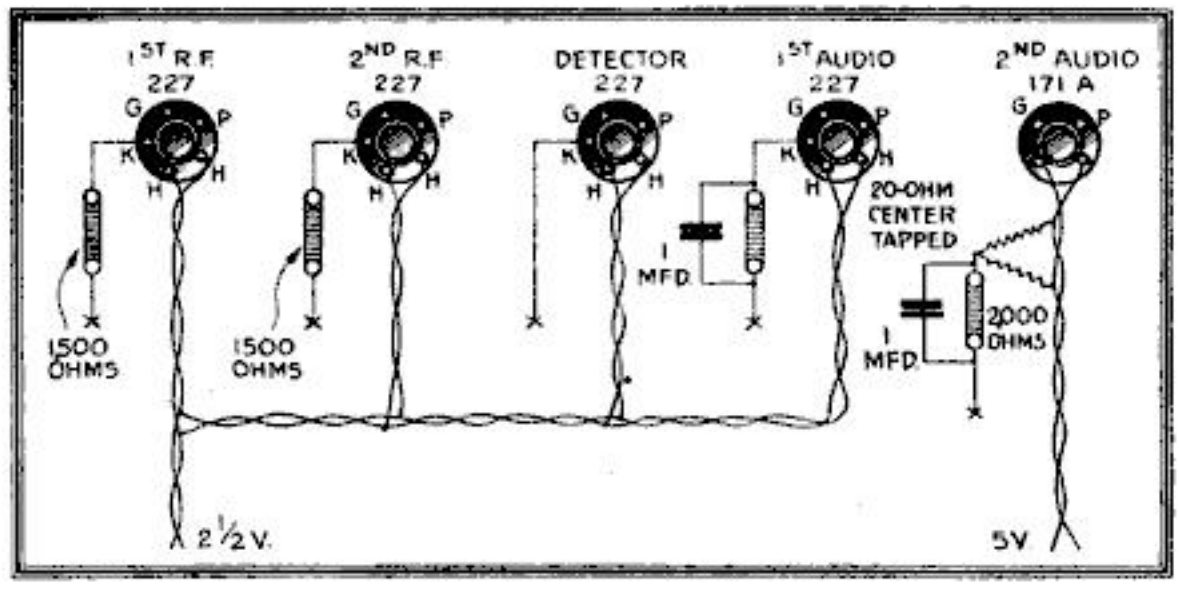


Diagram showing new wiring necessary to change a battery operated set to one using type 227 A. C. heater tubes. The fixed resistance placed in the first audio stage is of 1,500 ohms.

Assume that the battery set is of the conventional five-tube type, with two tuned radio-frequency stages, a detector, and two audio stages; and that it is now operated with a storage battery and a B eliminator. The new apparatus necessary to change it over to full electric operation with type 227 tubes will consist of four Y-type sockets, three 1,500-ohm fixed resistances, two one-microfarad by-pass condensers, one 2,000-ohm fixed resistance, and one twenty-ohm center tapped fixed resistance. A filament heating transformer capable of delivering two and one half volts, and with sufficient output to supply four 227 tubes, will be necessary. If your B eliminator is not fitted with a separate five-volt winding suitable for operating the filament of the type 171A tube, a small five-volt filament heating transformer will be needed.

Remove the wires leading to the G and P terminals of the radio-frequency, detector, and first audio sockets, and cut the filament wiring loose right at the socket. Connect each pair of filament leads that supplied battery current to the old sockets together. On the last socket, which holds the 171A tube, simply remove the two filament wires and connect them together. Then refer to the accompanying diagram. Place the Y-type sockets in position and reconnect the G and P terminals. The H or heater terminals are connected in parallel by twisted wires to twisted wires running to the two and one half volt winding of the filament heating transformer. The last audio socket filament terminals are connected by twisted wires to the five-volt filament heating transformer winding. The K terminal of the detector socket goes to the old filament wiring at the nearest point. The K terminals of the radio-frequency sockets are connected to 1,500-ohm resistances and the other terminal of the resistance connected to the old filament wiring at the nearest point.

This applies to the first audio socket also, except that a one-microfarad by-pass condenser is connected around the resistance. Connect the ends of the twenty-ohm center tapped fixed resistance to the five-volt winding. The 2,000-ohm fixed resistance is connected in with one end to the old filament wiring. The "X" in the diagram represents the nearest point on the old battery filament wiring. The B eliminator iscon nected to the "minus B," "detector" and "amplifier" binding posts as usual.

If the receiver lacks sensitiveness, bypass one or both of the 1,500-ohm resistances on the radio-frequency stages. A quarter or half microfarad condenser is ample. If the set is a six-tube outfit, another Y-tube socket and another 1,500-ohm resistance will be needed.

For volume control use a high resistance, noninductive, noncapacitive potentiometer connected across the antenna and ground binding posts with the antenna lead connected to the contact arm.

Use Headphones for "DX"

EAR phones are superior to a loudspeaker in hunting distant stations, as even very faint signals can be heard and headphone reception late at night does not disturb sleeping neighbors.

It isn't practical, however, to connect the headphones in place of the loudspeaker without some way of decreasing the volume. The simplest method of doing this is to use a high grade variable resistance connected across the output terminals in parallel with the headphone cord tips. Special output volume control units suitable for this purpose are available that will make it unnecessary to do any wiring inside the receiver.

The set's normal volume control cannot be used because turning it down reduces the radio-frequency amplification, very necessary for distance reception.

A B C's of Radio

THE selectivity of any radio receiver is always poorer on the lower wave lengths. Their power and frequency separations being equal, it is easier to choose between stations when they are near the upper end of the broadcast band of wave lengths. A radio receiver is not a miracle worker. It cannot separate stations if they are on the same wave length, and a check-up of the assigned frequencies in use in this country shows that near the low end of the dial there are many points where two or more stations should be received at exactly the same point.

In theory, the assignments are such that stations supposed to be working on the same wave length or frequency are located far apart. In practice, however, the great range of even the smallest station on a good night results in a hopeless hash at many points on the dial. There seems to be no way to improve the situation except by eliminating many of the stations now broadcasting.

Easy Ways to Shut Out Man-Made Static

By JOHN CARR

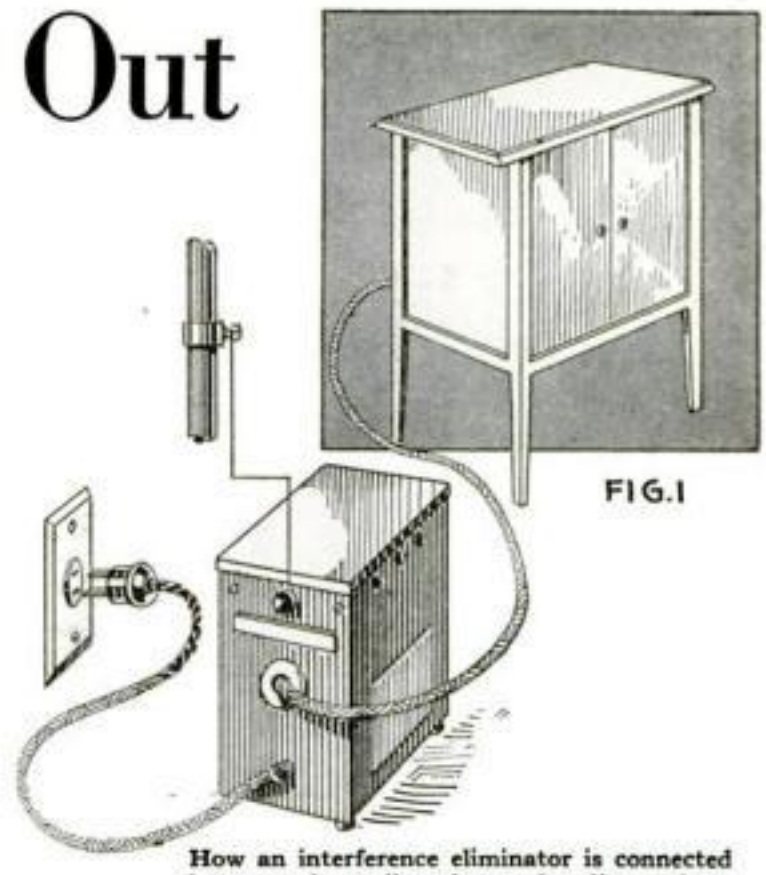


FIG. 1

How an interference eliminator is connected between the wall socket and radio receiver.

ALTHOUGH natural static is a radio nuisance for which no remedy has been found, man-made static, including all types of interference produced by electrical machinery, can, in many cases, be eliminated.

Whenever extraneous noises interfere with radio reception the first step, therefore, is to determine to which type of interference they belong. The test is simple. Disconnect the antenna wire from the receiver, and if the interfering noise disappears immediately, it is safe to say that it is caused by natural static or by man-made static that is not coming in by way of the power wires that supply current to the electric set.

If, on the other hand, the noise continues, the trouble almost surely is caused by man-made static coming over the power wires unless, of course, there is something defective in the set itself, such as a loose connection. If a check-up indicates there is nothing wrong with the set the solution of the problem is as shown in Figure 1. An approved type of interference eliminator is connected between the wall socket and the radio set. This automatically eliminates interference coming in by way of the power wiring.

Interference eliminators may be of two different types. The simpler contains only filter condensers wired as shown in Figure 2-a. The effect of these condensers is to by-pass the sudden pulsations that make interference noises.

Cases where the interference is severe may require a more elaborate eliminator. In addition to the condensers, radio-frequency choke coils must be connected in the circuit as shown in Figure 2-b. The condensers provide an easy path for the interfering pulsations, and the choke coils, although they have no appreciable retarding effect on the sixty-cycle current that runs the set, provide a very difficult path. In effect, the radio-frequency chokes form a barrier across a road, with the by-pass condensers providing a detour around the electrical path through the radio set.

The principal source of man-made static is an electrical spark, produced at the contact of a switch, at the commutator of a motor, by a trolley sliding along an overhead wire, or wherever the flow of electric current is suddenly interrupted.

An electric spark, tests have shown, always produces trains of untuned high frequency electrical oscillations. In character these are essentially the same as the radio broadcast wave except, of course, that they are virtually untuned, so that they usually can be heard at any point on the dial. They flow away from the point at which the spark occurs through both sides of the wire and thus along the power wiring into the radio set.

If the spark is exceptionally strong it will produce a radiation in the air from the wire. This form of man-made static in many cases is incurable, particularly if there is no way by which the spark oscillations can be smothered at their source.

The factory built interference eliminators illustrated in Figure 3, or similar home assembled outfits, may be used either at the receiver to prevent man-made static from getting into the set by way of the wiring, or to kill the interfering oscillations at their source, provided the source can be located. In a large apartment house, for instance, where many switches are being turned on and off at frequent intervals and other electrical apparatus is in use, an interference eliminator will provide good results if connected between the radio receiver and the wall socket. In cases where most of the interference is caused by one or two pieces of machinery, it is more effective to place the eliminator in the power wiring circuit as close to the interfering machinery as possible.

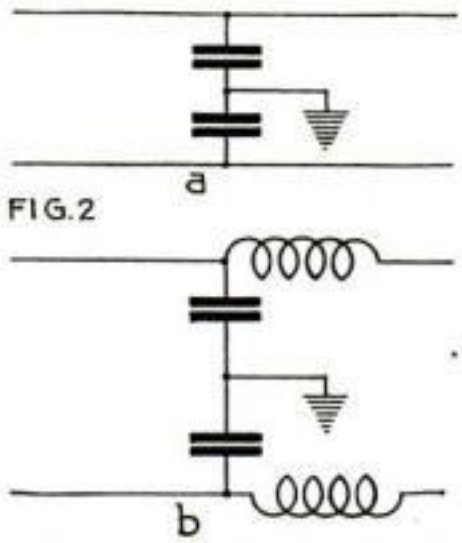


FIG. 2

Hook-ups for eliminator with filter condensers only (a) and with radio-frequency choke coils (b).

According to a recent survey made by the power companies, industrial apparatus is responsible for slightly less than one third of the man-made static. Household appliances, on the other hand, cause about one quarter of this form of interference.

IF THE application of an interference eliminator to the receiver fails to affect a cure, the first problem is to determine the time of day when the interference occurs. This often provides a clue to its general source. If, for example, the interference starts at eight o'clock in the morning on weekdays and goes almost continuously or at periodic intervals up to five or six o'clock and there is no interference on Sundays, then almost certainly it is caused by machinery in use in a near-by factory or store. It then becomes a matter of scouting around until the source of trouble is located. Usually the owner of the disturbance-causing apparatus will gladly coöperate.

Suppose, on the other hand, that the noise always starts in just about sundown and continues through the evening up to ten or eleven o'clock. This would indicate that the mechanism operating an electric flashing sign is causing the trouble. Once located, the application of an interference eliminator, or a specially designed filtering circuit if the sign is a very large one, will eliminate the trouble. If the noise occurs only on one or two nights a week at about ten or eleven o'clock and continues all night and perhaps the next day, it is likely to be caused by an old-type buzzer rectifier battery charger. Here, too, the remedy will be simple once it is located.

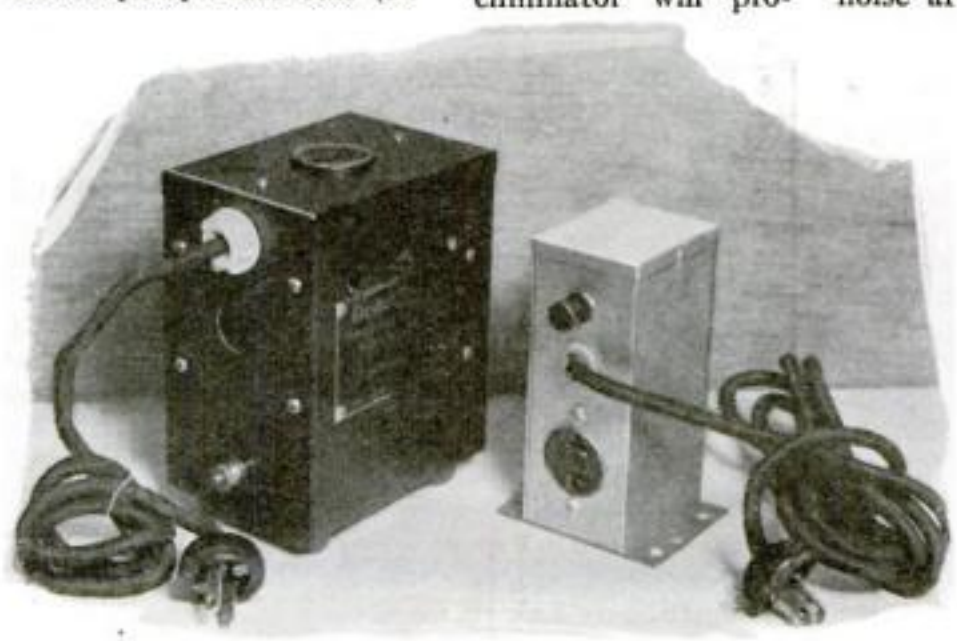


Fig. 3. Two types of factory-built interference eliminators. They can be used either at the receiving set or at the source of the interference.

"Where are your chains?" asked Gus. "Never use them," snapped Morrison; "they're no good."

Gus Explains

Why Tire Chains Are Safest

And Demonstrates His Point by Using Them to Pull the Car of an Unbelieving Motorist Out of the Mud

By

MARTIN BUNN

"I'VE been expecting a call like this from Morrison," Gus Wilson grumbled to his partner, Joe Clark, as they stopped the Model Garage service car beside an expensive new coach job that was stuck in the mud.

"Where are your chains, Mr. Morrison?" asked Gus, as he noticed the position of the stuck car.

"Never use 'em," snapped Morrison; "they're no good."

Gus said nothing. Previous experience with Morrison had shown him the futility of arguing with an obstinate, opinionated rich man. Instead, the veteran auto mechanic dug around in the back of the service car and pulled out a pair of chains big enough to go around Morrison's tires.

"So you don't believe in chains, Mr. Morrison," he remarked. "Now just watch what chains will do for your car."

One rear wheel of the car still remained on the concrete of the highway but rested on a smooth coating of ice. The other wheel had sunk several inches into a bog of half frozen mud at the edge of the road.

Gus stretched one of the chains on the ice-covered pavement in front of the up wheel and hooked the end nearest the tread over the tire and around one of the spokes.

"Watch it now, Joe," he said as he got into the car and let the clutch in gently. The wheel in the mud remained stationary, but the other started to turn, pulling the chain toward it along the ice until a cross link caught under the tread. The links bit into the ice and stopped the wheel from slipping. The bogged wheel started to churn in the mud, but, as the tire had a good tread and the mud had a relatively solid bottom, the car crept forward, rolling onto the chain. By the time the chain was completely around the tire the car was almost back on the road.

"Well, what do you know about that!" exclaimed Morrison in amazement. "I thought all the time that the wheel in the mud was doing the slipping."

"It all depends on the kind of mud," Gus explained. "If there wasn't any ice on the road and the car got stuck you could be pretty sure the wheel was bogged in one of those soupy mixtures that simply won't give any traction. In that case this stunt wouldn't work. You'd have to put the chain on the wheel in the mud."

"It's funny I never seem to have any luck with chains," Morrison puzzled. "I got into a beautiful skid with chains on once, so I decided they weren't any good."

"Chains do act queer at times," admitted Gus. "Trouble is, people think that with chains on, the wheels simply can't slide; so they jam on the brakes too suddenly or try to go round corners too fast. If you happen to lock the wheels at a point where there isn't any cross chain in contact with the pavement the wheels will slide on the rubber in grand style; but there's lots of going where you can't navigate at all unless you do have chains. Of course, though, you can get along on wet pavements without 'em especially if you let a little air out of your tires.

"SEEMS to me," Gus continued, "that the cost of a pair of chains is so small that it isn't worth risking an expensive car without 'em. Every car owner ought to have a pair of chains parked under the back seat.

"A fellow I know didn't believe in chains and he went on a long trip in summer without 'em. One day he got caught in a terrible downpour of rain and he had to make a detour from the main road. He met another car coming the other way that hogged more than half the road. The fellow that didn't like chains got stuck in some deep mud and stayed there until he hired a farmer (Continued on page 146)

GUS SAYS—

AUTOMOBILE tinkeritis is a kind of a disease. It's just the opposite of carelessness and indifference—sort of like the difference between chills and fever. One man gets a chill every time he thinks about doing any work on the car. The tinkeritis chap is always in a fever to do something whether it needs doing or not. He just can't keep his hands off a monkey wrench or a screw driver and his car is in pieces a good part of the time. The other fellow's car goes to pieces all by itself, if he doesn't turn it in for a new one when it starts to rattle.

It's uncomfortable to be chilly and there's no fun in a fever. Be temperate—fix things when they need fixing, but don't spend all your time snooping around for trouble that most likely isn't there.

POPULAR SCIENCE HOME WORKSHOP

Articles on Furniture, Models, Toys, Sporting Equipment, and All Forms of Craft Work—Better Shop Methods—The Shipshape Home

Seascoot—A Family Motor Boat

Sturdiness of construction and seaworthiness of design make the *Seascoot* a general utility boat.

THIS simple, inexpensive, sturdy outboard motor boat was designed especially for readers of POPULAR SCIENCE MONTHLY by Mr. Crosby, who is a marine architect of long experience and editor of *The Rudder*. To make sure no problems had been overlooked, Mr. Crosby went a step further and, with the aid of one of his friends, actually built the boat. His instructions, therefore, can be followed by the beginner with absolute assurance of success.

By

W. F. CROSBY

The 15½-ft. *Seascoot* has a spacious row of seats in the bow and a large seat in the stern.

WHEN POPULAR SCIENCE MONTHLY requested me to write a "how-to" article on building a small outboard boat for fishing and family use, I had no idea that before I was through with the job *Seascoot* would actually come into being. I expected to furnish the design, write a few words of advice on building the boat, and let it go at that. But no, photographs of the boat under construction were wanted, and the only way to take these was to build the boat.

Seascoot is now complete and in the water, and it was not so much of a job after all. It took two of us about nine working days, or eighteen days in all. We had built small boats before, so it may take you a little longer.

One thing was borne in mind in designing: that was to make *Seascoot* a rather heavy boat, a safe and sane craft for hunting, camping, and fishing trips. If need be, she might be used on small lakes for running over to get the mail or doing sundry other jobs.

She was designed to be 15 ft. 6 in. in length for several good reasons. The first of these was because boats under 16 ft. long do not require a Government license, and the second was because it is easy to get planks 16 ft. in length, thus doing away with the job of making butts. She has a beam, or width, of 5 ft. and may be counted upon, with her flat bottom, to be more than steady even when two or three people get over to one side. The lines forward were flared out a little to keep down loose spray; and the stern was reversed a little, or given tumble home, as it is sometimes called, in order to provide plenty of "bearing" on the water and to prevent settling when the engine is running. This has resulted in a boat with pleasing and entirely practical lines.

In order to keep the boat within reasonable cost and to make it easy to build, it was decided that the best form would be a perfectly flat bottom. This is the very simplest construction. In the entire boat there is no place where one has any need to resort to that bugbear of boat building, steam bending. The side planks are run fore and aft, and one man with an assistant can bend them easily in place if they are fastened near the bow first and then bent around the frames, fastenings being put in as the work progresses in order to prevent the board from buckling. The planks on the bottom are put on crossways, or athwartships, as this also is easier to do and is better from the standpoint of preventing leakage.

IN BUYING the materials, we were agreeably surprised to find that the entire cost was well under fifty dollars.

If you plan to build the boat in a cellar, be sure that there is a means of getting it out of doors when it is completed. We started the boat in the cellar and finished it in the garage. Under no conditions plank the boat in a heated place, because heat will cause the lumber to dry out unevenly and will result ultimately in an unsatisfactory planking job.

The first step was to make a full sized set of sections exactly as shown in the drawing on page 76. With the dimensions before us, it did not take long to strike in a base line on the floor and then another line at right angles to it which represented a center line. A straight piece of wood was used as a straightedge for this work; this and a six-foot rule of the usual variety were all of the tools necessary for laying out. Of course, a pencil with a sharp point was required to draw the lines, so that they could be followed closely.

Instead of laying out each section separately as shown in the drawing, it was decided to draw each one directly over the other. There are only four of them, and it is easy enough to distinguish between them. In other words, only one center line was used for the lot.

Section No. 1 was laid out first. The rule was laid parallel to the base line and the dimension marked off from the center line out to the point where the side and bottom boards meet. This is called the chine, and will be referred to by this name from now on. The 20¼ and 26 in. dimensions, as given in the drawing, were then marked off. We then referred to the profile drawing and measured up from the base line 2¾ in. to the chine and from this point on up to the deck line 22 in. above. This gave us the heights of the chine and the deck, and the two previous dimensions were carried over so that they crossed these two, giving us two points of intersection, one at the chine and the other at the deck. The same procedure was repeated on the other side of the center line so that when finished we had simply to connect these points and we had the exact shape at section No. 1.

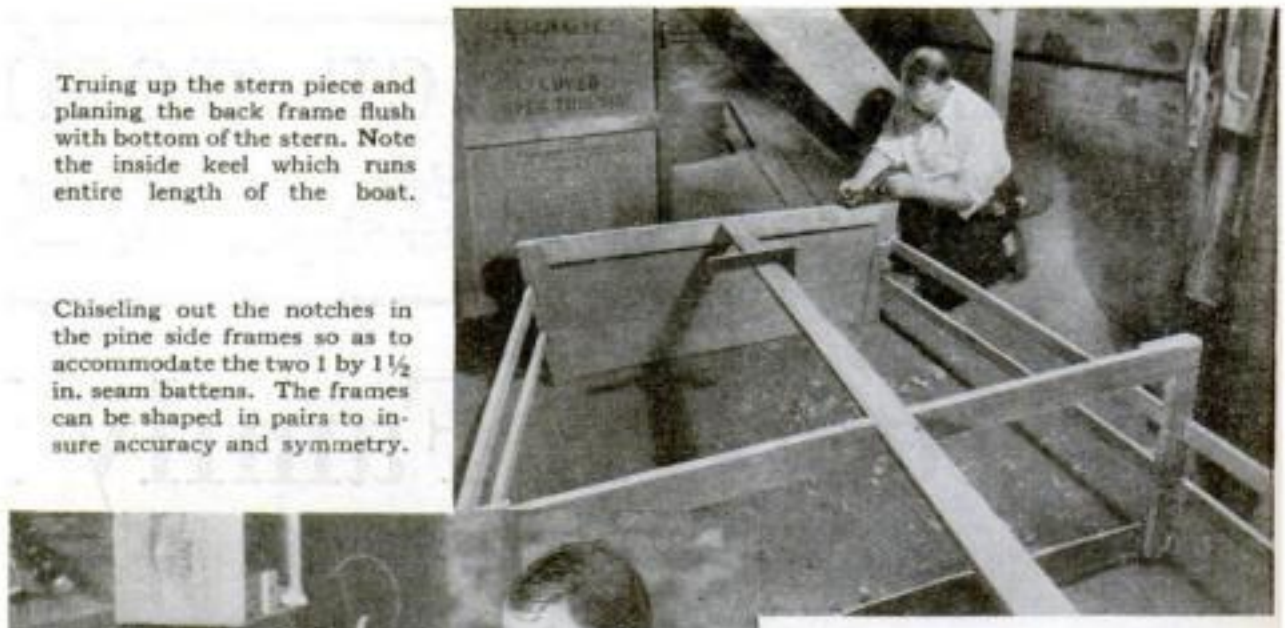
Since all boats are designed to the outside of the planking, it now became necessary to deduct this from the lines as laid down on the floor. By referring to the drawing we find that the bottom planking

is ¼ in. thick and the side material ½ in. This meant that we marked off these fractions on the lines of this section and redrew the real section line ½ in. inside for the sides and ¾ in. in for the bottom. We now had the shape of the first frame. Two pieces of stock each about 24 in. long were cut for the side frames. This length allowed several inches leeway. A third piece was cut next for the cross frame at the bottom, and this was laid exactly on the line that we have just made on the floor. The ends of this piece were then marked carefully with a bevel to conform to the slant of the side frames, and any excess wood was removed. The side frames were fitted exactly to the upper edge of this bottom frame and their bottoms beveled to fit exactly the angle made by the two sections. A little care during this work will save a lot of trouble later on in the construction.

Before joining the two sections together, it was necessary to cut a notch in the exact center of the lower frame for the inner keel. We sawed a short sample of the inner keel material, and using this as a model we marked the exact center of the frame, fastened it securely in a vise, and proceeded to fit the piece snugly.

The side frames, too, had to be notched to receive the fore and aft strips that are called seam battens. We divided the side frame into three equal parts, from sheer to chine, allowing for thickness of lower or bottom frame, and notches were cut to fit the material for the seam battens. A model piece was used in this procedure also.

We found that errors in laying out the frames could be avoided if all frames were clearly marked with their number and



Truing up the stern piece and planing the back frame flush with bottom of the stern. Note the inside keel which runs entire length of the boat.

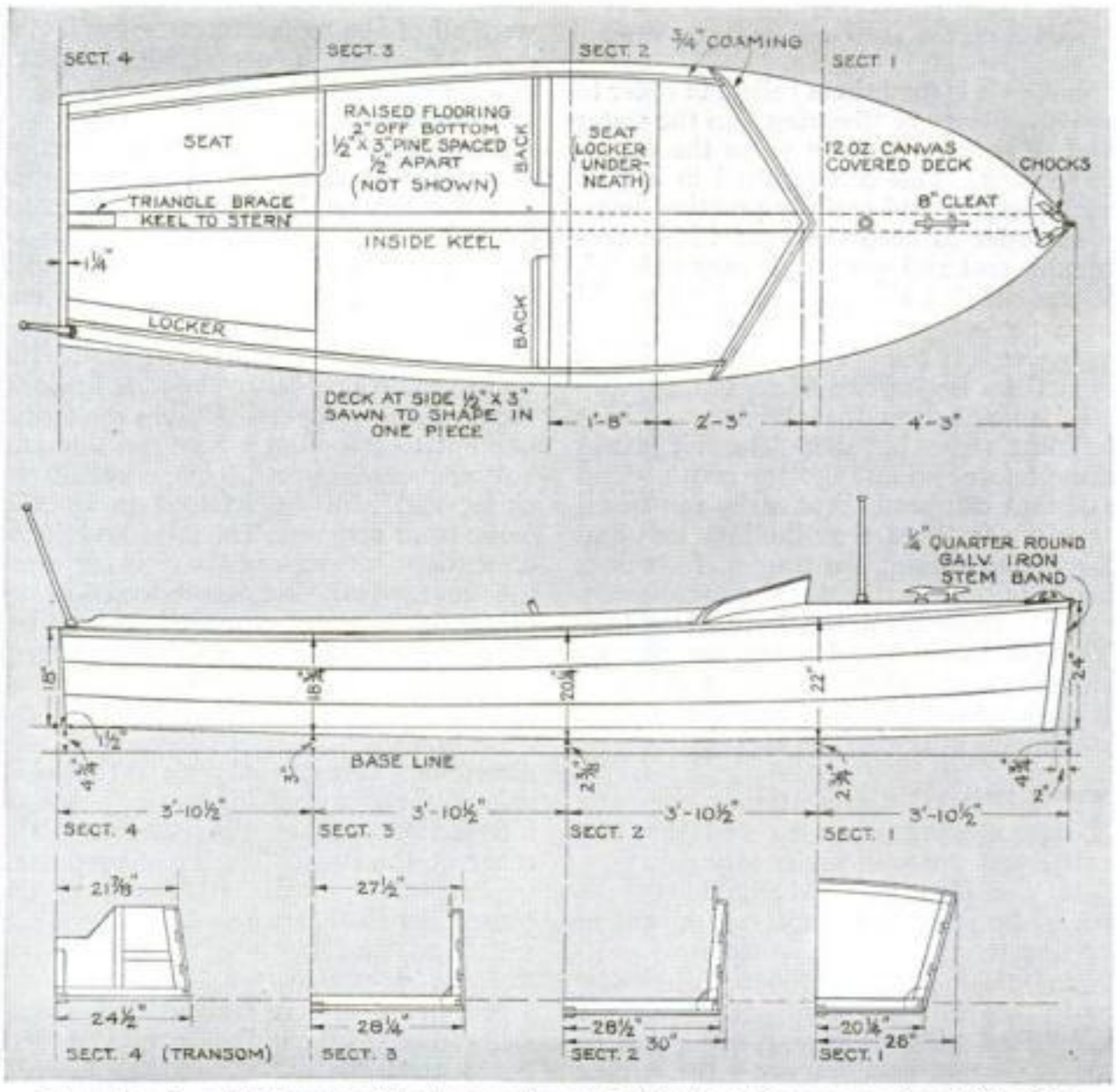
Chiseling out the notches in the pine side frames so as to accommodate the two 1 by 1½ in. seam battens. The frames can be shaped in pairs to insure accuracy and symmetry.

their outer edges designated with a large X. The notches for the side frames can be made in one operation by clamping them together in a vise.

When all the notches were made, the two side frames and the bottom frame were again laid down on the drawing on the floor and the three pieces fitted together. Another piece of wood, called a bracket, was then fitted to cover the junction and placed to allow plenty of material on each side. The grain in this piece should run at an angle of about 45 degrees with the bottom piece so that when the strain comes it will not split. In our boat a piece was fastened on each side to make doubly certain that no split would occur.

These pieces were fitted closely to the outer edges of the frames and were fastened to the frames with 1¼-in. No. 7 brass screws. Never use iron screws if a boat is to be used in salt water. Each screw hole was drilled ¾ in. deep, using a drill slightly smaller than the shank of the screw. Each screw was soaped before it was started.

After we were sure that the frame followed the pencil line all the way around, we nailed a piece of ¾ by 3 in. stock



Assembly views of the boat and the four sections at which the side frames are placed. All of the materials needed in the construction of the *Seascoot* cost considerably less than fifty dollars.

BILL OF MATERIALS

Part	No. Pcs.	Stock	T in.	W in.	L ft.
Sides	6	Cypress or pine	½	10	16
Bottom and seats	8	Cypress or pine	¾	10	16
Battens	4	Spruce or pine	½	1½	16
Chines and Keels	4	Spruce or pine	1	2	16
Frames	5	Spruce or pine	1	2	16
Transom	2	Oak	1¼	9	4
Stem	1	Oak	3	3	2
Moldings	2	Oak, ½-rd.	...	1	16
Floor, etc.	4	Cypress or pine	½	3	16

Screws	432	No. 7 brass	1 in.
Screws	288	No. 7 brass	1¼ in.
Screws	36	No. 8 brass	2 in.
Screws	120	No. 8 brass	1¾ in.
Nails	1 lb.	Galv. iron	1 in.
Tacks	1 bx.	Copper	⅜ in.
Canvas	1	12 oz.	50 in. square

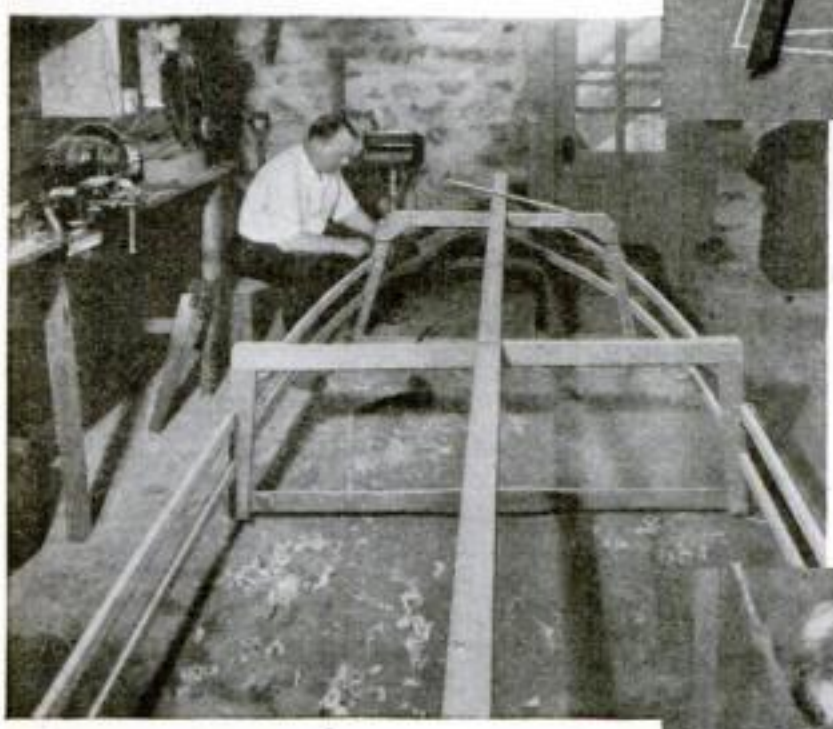
2 qts. battleship gray paint for interior
2 qts. yacht white for outside
2 qts. red or green copper bottom paint
1 qt. buff paint for deck, seats, and trim
1 qt. of turpentine
1 lb. marine seam composition
1 qt. aviation glue
Assorted sandpaper, No. 2 to No. 00
Brushes

These materials purchased in New York City cost less than fifty dollars.

across the top to hold the loose ends at exactly equal distances. The center line was marked on this piece also, giving us a handy check. These crosspieces were attached well above the sheer mark.

Too much stress cannot be put on the necessity for accuracy in the laying down of the frames, as an error at this stage of the construction will ruin the chances of building a successful boat.

Exactly the same procedure was followed in laying down all of the other frames. The second frame is larger than the first, but was made in the same way. The shape of the third frame indicates that the sides are starting to tumble home a little, as it is wider at the chine than it is at the deck line. It was necessary to respace the notches for the seam battens on each frame as we went along, at the same time being sure to allow for the thickness of the planking in figuring each one.



The sections were laid out full size on the floor, one over the other. Although these show as chalk marks in the illustration, a sharp lead pencil was used, as it allowed more accuracy.

Putting one of the sections in place. Much of the final success depends on this portion of the construction, as any inaccuracy will throw the boat out of shape.

Assembling the pieces that go to make up one of the side frames. Note the section lines laid out on the floor.

The oak stock for the last frame or stern piece was laid over the markings on the floor in such a way that it could easily be marked. The excess wood was sawed off and some of the stock for the frames was taken and screwed fast to the edges, bringing them out flush. These pieces take the ends of the planking because screws hold better in them than in the end grain of the stern piece. The thickness of the planking was deducted and the frames screwed to the transom in the usual way. No side brackets are necessary here, as the stern piece will take their place. These sidepieces were cut out and spaced for the ends of the seam battens, and the crosspiece at the bottom was notched to take the inside keel.

In placing the screws we staggered them so that no two screws would come within 6 in. of each other within the same grain of the wood. This was done to eliminate splitting. In other words, one screw was placed near the right-hand edge and the next one near the left-hand edge, and so on.

We now had all the frames and the transom complete, and the next step was to make the piece for the bow, sometimes called the stem piece. It was made of oak and was cut a little over 2 ft. in length and 3 in. square to start with. We shaped it roughly triangular and cut in a rabbet or notch for the ends of the side planks. Another way of doing the job would have been to take two pieces of wood and fasten them together so that the joint forms one end of the rabbet line. Then by chiseling off a little of the other edge, it would have been possible to make a very accurate rabbet.

When this work was complete, we set the frames up temporarily at their proper distances and then ran in the seam battens and the keel to hold them together. A little cord here and there served to make the structure strong enough to work with. The stem was also set up and the seam battens drawn together in front of it and tied with short lengths of wire and rope. This gave us a guide to go by in notching the stem (in back of the rabbet) for the ends of the seam battens. These were set in flush, just inside the planking line. It was also necessary to bevel off the outer edge of the first frame and to remove about half an inch of material on the forward side of this frame. The other frames are so nearly square that it was not necessary to do any beveling.

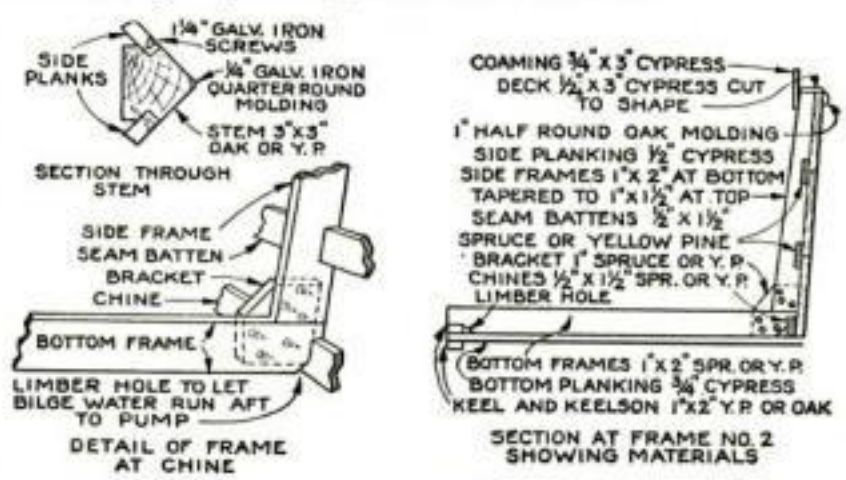
The piece that backs the chine was fitted at this time. This is called the chine log, although it is not any more of a log than the seam battens. It runs at the point where the side meets the bottom from bow to stern. The frames were notched out to fit the chine log.

At about this time we decided that the work had gone far enough in the cellar and the entire structure was "untied" and set up again in the garage. It is customary to build such boats keel up, as they are considerably easier to plank in this position. Accordingly each frame was set up at exactly the distance given in the drawing, 3 ft. 10½ in., and the keel screwed in place. One seam batten was run in on each side and screwed to each frame. At the bow the two ends were brought together into the notches cut in the stem piece and screwed in place. The keel was also screwed to the butt of the stem but not until the proper overhang had been secured—2 in.—as shown in the plans.

You will note that the bottom of the boat has a slight "rocker" to it. In other words, the center is a little lower than the two ends. In order to secure this the stem and stern were permitted to rest on the floor while the three more central frames were lifted off the floor by blocking. The stem and stern tried to rise also but we held them down with braces which ran up to the ceiling. At section No. 2 the bottom of the boat is 2⅜ in. higher (since we are building her upside down) than the ends.

The other seam batten was now bent into place and screwed to each frame, to the stem, and to the stern. Although it was not absolutely necessary, we painted the entire framework before proceeding further.

Next month we shall complete the planking and finish the boat.



Details of the side frame construction and the stem piece. Small holes, often called limber holes, allow the bilge water to flow aft.

Learning to Use a Small Lathe

Trestle Gate Table of True Colonial Design Serves as Object Lesson in Studying Spindle Turning Operations

By WILLIAM W. KLENKE

Fig. 1. The table, which can be made of walnut, maple, or mahogany, could not be purchased for less than five to seven times the cost of materials.

GENERALLY speaking, wood turning lathes can be divided into two main classes: direct motor-driven and those run with a belt. There is something to be said for and against each type, and the use of either of them is mainly a matter of personal preference.

The direct motor-driven outfit usually has only one speed, which for most turning is satisfactory, but presents difficulties where large diameter or long work is to be done. If the machine is supplied with a rheostat or some similar device for controlling the speed, you will find that as you reduce the speed you also reduce the power. On the other hand, the direct motor-driven outfit can be made more compact, and bothersome belts and shafting can be eliminated; because of this it is often very desirable for home workshop use.

The belt-driven lathe has the advantage of speed control, having as a rule three speeds. This variety of speeds is obtained by means of a stepped pulley; the motor itself always runs at the same rate of speed. With this type of machine you can connect a belt directly to the motor or use countershafting, which can be ut lized to operate other machines.

Good turning must always be done with as high a speed as is safe and practical to use, in order that the cuts made will be smooth. Long, thin, extra heavy, built-up, and rechucked work must be turned at a slow speed.

In building the table shown in Fig. 1 first prepare the stock, which can be any wood—although mahogany, walnut, or maple is preferred.

Run all pieces on the jointer to obtain a face and edge. Then rip these pieces on the circular saw to the approximate width and joint the sawed surfaces. Allow ½ in. at each end for waste when cutting to length. This is done to allow for the holes made by the lathe centers.

Step No. 1—Marking the Centers. On both ends of the various pieces to be turned draw two diagonal lines; the point of intersection will be the center. Another method is to set a marking gage to about half the thickness and gage lines from the four sides.

On all hard wood it is best to bore a small hole (about the size of the center point) deep enough to receive the point. This eliminates any tendency of the stock to split.

Step No. 2—Centers in Place. The two centers on the lathe are known as the live and dead centers. The live center (sometimes called a butterfly center) is the one having blades which grasp the wood.

Remove the live center from the lathe and gently drive it in one end of the wood to be turned, so that the point goes into the hole just bored and the blades enter the wood for about ⅛ in. Use a wooden mallet in driving in the center.

Step No. 3—Placing the Work in the Lathe. The live center end is placed in position first and the tailstock is moved up close to the work. Clamp the tailstock securely in place, hold the wood with the left hand, and then screw up on the spindle adjustment until the dead center enters the wood. It must be tight enough to hold the work up against the live center and yet not so tight that the wood will not turn freely when revolved by hand (see Fig. 2). Place a drop of oil on the dead center to avoid friction and the ultimate burning of the wood at the point of contact.

Step No. 4—Tool Rest. The tool rest, as the name implies, is for the tool to rest and slide on while the turning is being done. The position of this during the turning operation is most important. Turn the wood so that two opposite corners are on a level. Move the tool rest up close to the wood, allowing a space between the wood and the rest of about ¼ in., and securely fasten all adjustments. The height should be about on a line with the centers. Test the position by revolving the wood several times by hand. Some wood turners, however, prefer to place it a little above the center line (see Fig. 3).

Step No. 5—Roughing Off. If you have

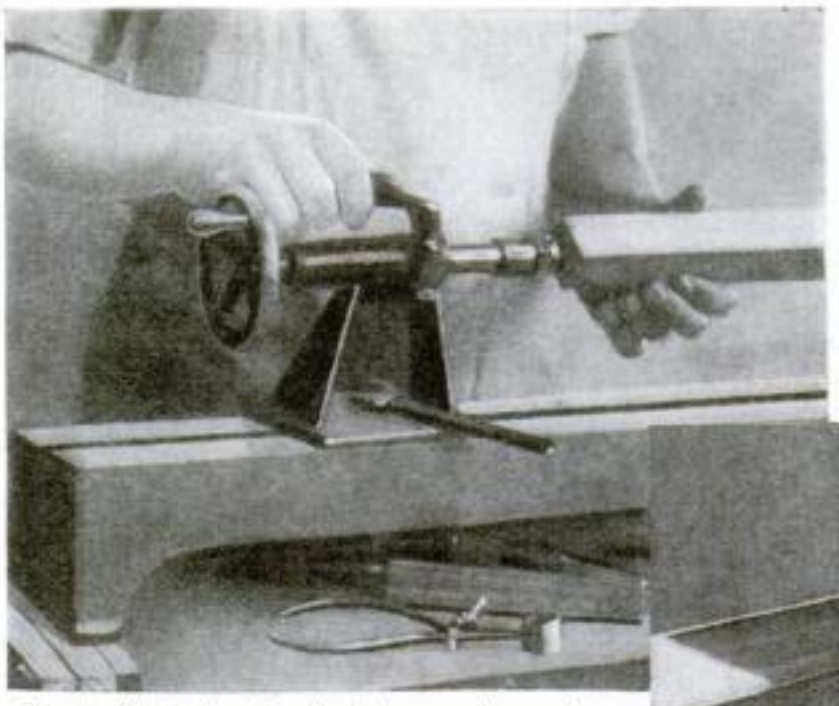


Fig. 2. The tail center should engage the work quite firmly, but not so tightly as to bind.

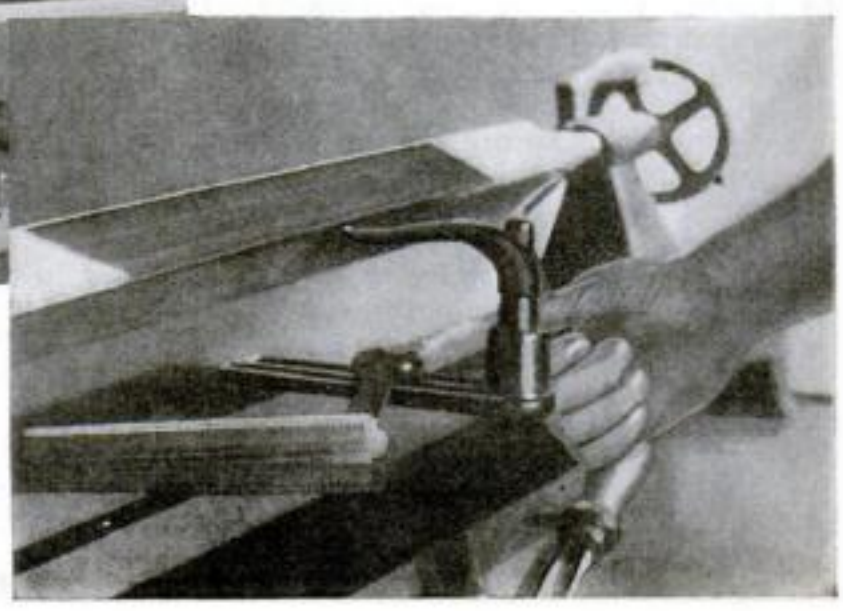


Fig. 3. The height of the tool rest is most important. The edge should be about on a line with the center and approximately ¼ in. away from the corners of the stock as it revolves. The rest is moved in as the work progresses.

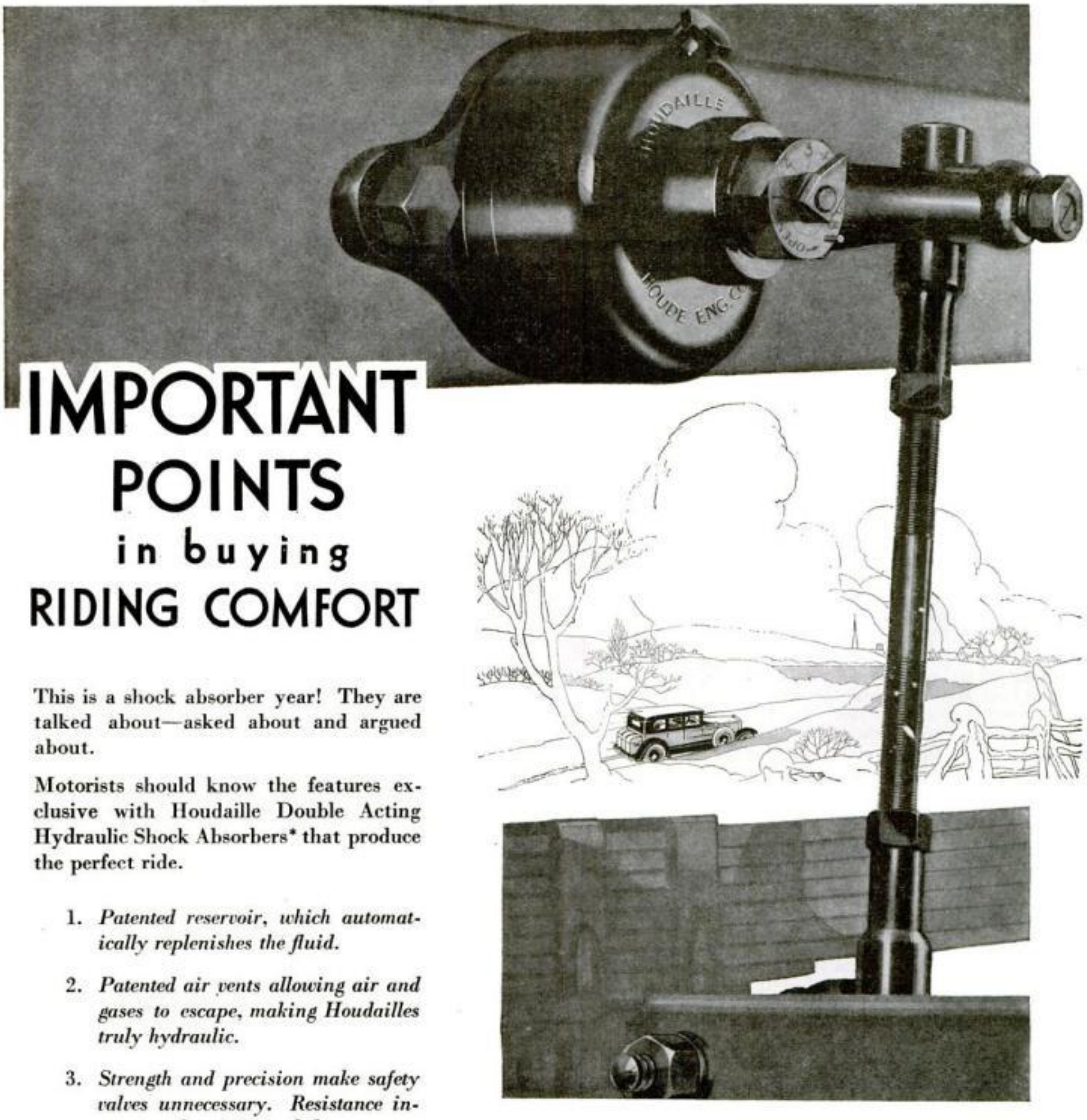


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Fig. 4. The gouge is the tool used in the first operation, which is called "roughing."

never done any turning before, it is advisable to do a little practicing on some scrap wood at first.

The first tool to be used is the gouge (see Fig. 4). While the wood revolves, gently bring the gouge forward until it is in contact with the wood; and then work the tool back and forth until the corners of the work are all rounded off. The gouge is tilted a little to the right or left, depending upon the direction in which the tool is moving. This is done to throw the chips away from your face.

Step No. 6—Use of Calipers. In order to turn to any desired diameter, it is necessary to use a pair of calipers and a parting tool (see Fig. 5). Great care must be taken to hold the calipers at right angles to the axis of the work and to watch that the calipers do not ride on top of the parting tool, thereby preventing them from sliding down in the working groove. There is a tool called the turners' sizer, which is a combination of a parting tool and calipers. Such a tool is valuable in shops where many pieces are to be turned to the same diameter.

The general procedure in spindle turning is as follows:

First, rough off all work with a gouge until the wood is round; then use the parting tool and calipers and turn the work down to the largest diameter. Next, cut down on both ends to the length, leaving as much wood at the centers as possible. Then, in turn, part down to the various surfaces, always starting with the largest diameters. Finally, work out the beads to the required design.

While the work revolves in the lathe, do all necessary sandpapering, being careful not to round off the sharp corners.

The steps for the construction of the table are as follows:

Step No. 1—Mortises. Lay out all mortises. Place the chuck in the lathe with the correct size bit and bore out all mortises, using the spindle adjustment on the tailstock to feed the work into the bit. Then chisel out the mortises clean and true by hand.

Step No. 2—Tenons. Use the circular saw for cutting all tenons. First place the wood flat and crosscut the shoulders. Then stand the stretcher and rail on end and rip the sides of the tenons to fit the mortises just made. Exercise extreme care in fitting these joints.

Step No. 3—The Feet. Lay out the curves for the feet and saw to these outlines on the band saw, later smoothing up the curves on a small drum sander.

Step No. 4—The Top. The top is made up of one narrow piece and two wide pieces, and has two rule joints. (If desired, a square edge joint may be used.)

First cut and fit the rule joint, working it out on a shaper; or rough it out on the

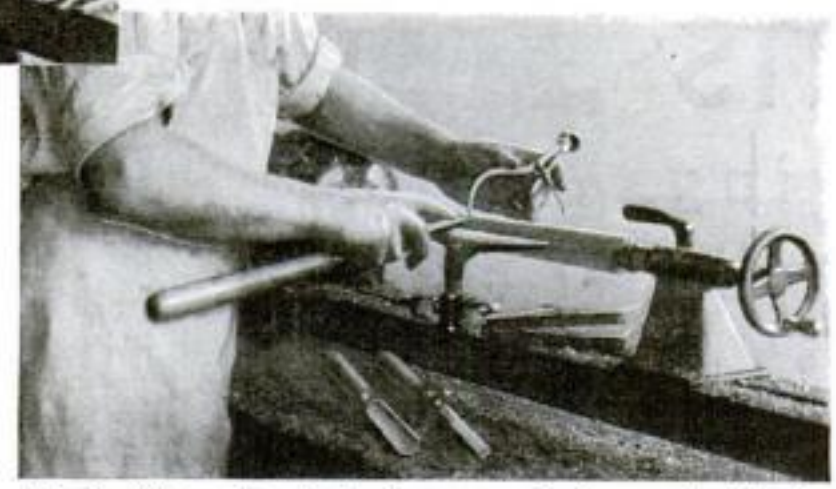

Fig. 5. The parting tool cuts a groove in the wood, while the calipers check the diameter. Notice how both the tools are held.

circular saw and true up the curves with a hand plane. Next place the three pieces together and lay out the oval outline, which can easily be done with three small brads, a string, and a pencil (see Fig. 6). Draw the major and the minor axis (the two center lines). From one end of the minor axis, strike two points, one on each side, on the major axis, with one half of the major axis as a radius. Drive a small brad at each of these two points and one at one end of the minor axis. Stretch a string around these three brads (forming a triangle), place a pencil in this loop, and scribe the ellipse. Cut the ellipse on a band or jig saw and smooth the edges.

Step No. 5—Assembly. Glue up the two legs, stretcher, and top-rails first and then glue on the feet. Note that all joints are pinned together with handmade pins, which are made to extend above the surfaces. (Be sure to insert the two swinging gates.) The top is hinged together with back flaps about ¾ by 3 in. and the top is screwed to the framework from the underside.

Step No. 6—Finish. Clean off all excess glue with a sharp chisel and thoroughly sandpaper all parts with No. ½, No. 0, and No. 00 sandpaper.

In previous articles I have given the finish for many different kinds of wood, so now I shall take up American walnut.

For a light finish, apply a coat of the correct color wood filler; when hard, give the table at least three or four coats of thin white shellac, rubbing down each coat with No. 00 sandpaper and the last coat with fine pumice and crude oil (or use common machine oil).

If you prefer a darker finish, apply one coat of boiled linseed oil before using the wood filler. Sap wood of walnut is very light in color and may be stained to match the heart wood before doing any finishing.

For those who wish additional information regarding different finishes, namely mahogany and maple, P.S.M., Jan. '30, p. 80, and P.S.M., Feb. '30, p. 88, are suggested as references.

If woods are to be imitated apply a coat of water stain or commercially prepared penetrating stain. When dry, apply thin coats of shellac.

This is the eighth of a series of articles in which Mr. Klenke, through the courtesy of various manufacturers, is demonstrating the use of many of the new motor-driven home workshop machines of both combination and single types.

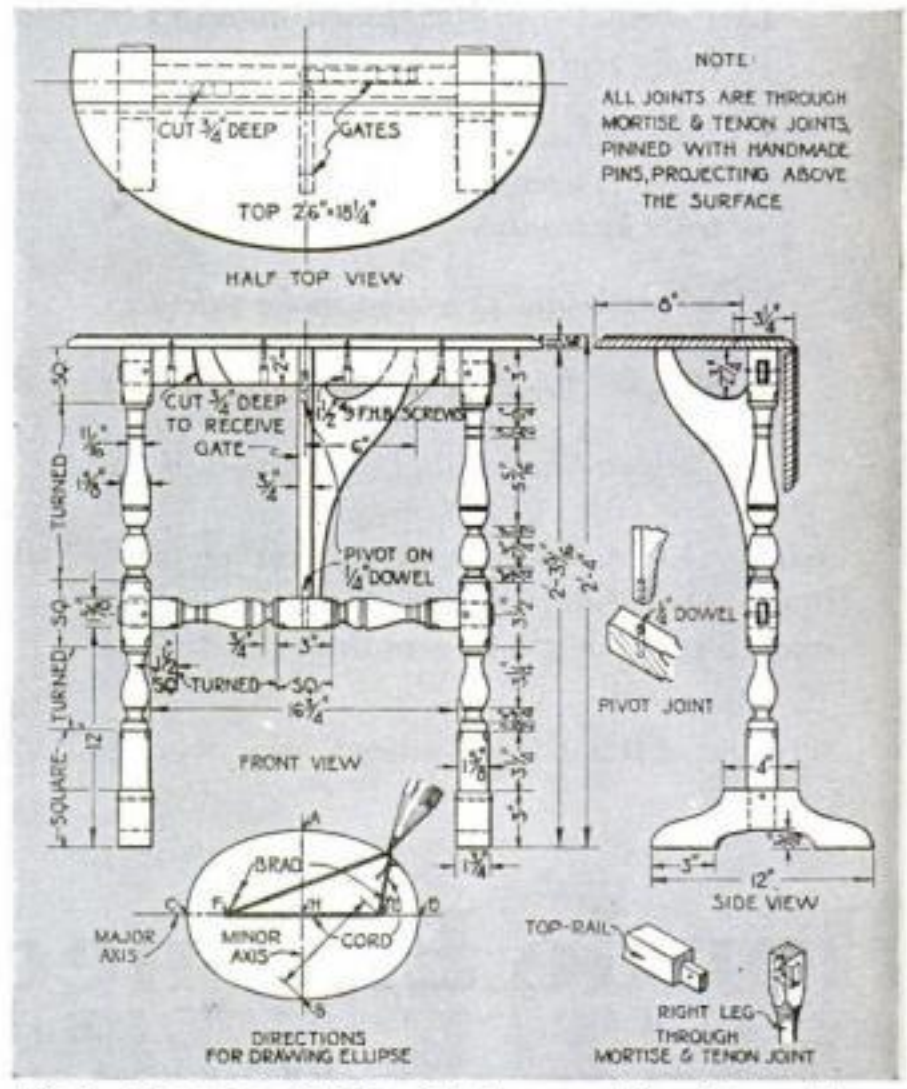

Fig. 6. Dimensions of table; pivot piece; mortise and tenon joints held with handmade pins; and the method of drawing the ellipse.

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How to Use a Soldering Iron

Fine Points in Handling the Copper Bit Skillfully and Making Neat, Strong Joints—Fluxes for Various Metals

By EDWARD THATCHER

PROBABLY no tool used by the amateur craftsman is so little understood as the useful soldering copper, or soldering iron as it is sometimes called. For fine work, there is really no substitute for this tool. It has the advantage of applying the heat and the solder within a limited space and does not warp small pieces of thin metal as does the blowtorch.

The choice of the size of the soldering copper depends on the type of work to be done. The copper must be large enough not only to supply sufficient heat to bring the solder to its melting point, but also to heat the joint.

Dirt and oxide are the great enemies of successful soldering, and because of this it is imperative that the four faces on the point of the copper be clean and bright. It is essential to clean up the four surfaces which form the point with a file or emery cloth (see Fig. 1).

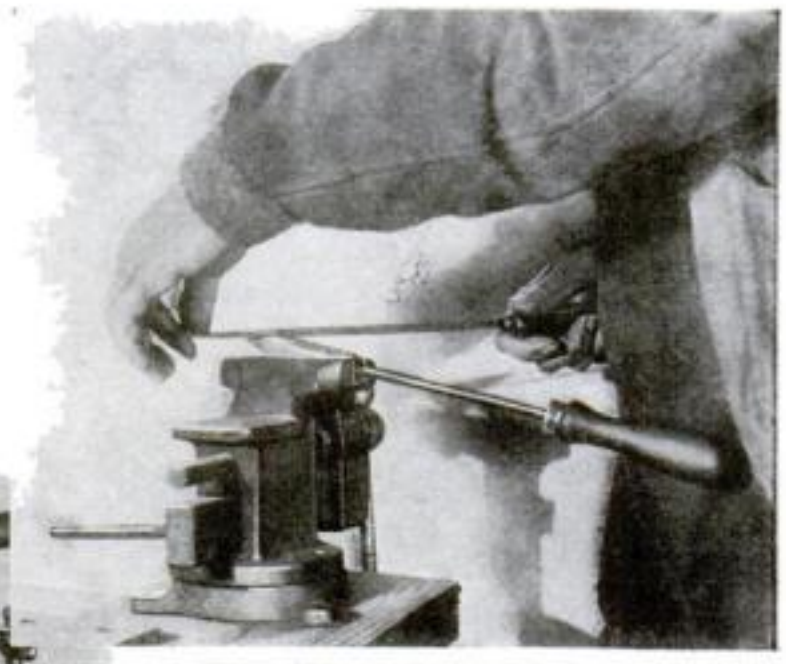


Fig. 1. Thoroughly clean the four faces of the point with a file or small piece of emery cloth.

Fig. 2. Never heat the soldering iron to a red heat or it will become badly oxidized and pitted.

In order to use the copper the four faces on the point must be tinned. To do this, apply killed acid (P.S.M., Jan. '30, p. 120) or commercial soldering flux to each of the faces and place the copper in the fire or over a blowtorch as shown in Fig. 2. Allow it to heat until it will melt soft solder—that is, ordinary bar or wire solder—easily. Remove the copper from the fire and rub each of the faces into some bits of solder which have been previously covered with flux and are resting on a piece of clean bright tin (see Fig. 3). Some of the solder will adhere to the four faces and form a thin coating.

It is quite important that the copper be kept at the melting point of the solder during this tinning operation even if it must be reheated several times. Be sure to keep the piece of tin with the flux and solder melted on it, as it will be useful in future retinning operations.

After the point has been tinned and while it is still hot, wipe each of the faces on a damp cloth to smooth up the tinned surfaces and remove the excess solder. It is well to keep a damp rag on the bench during all soldering operations. It is also an excellent practice to keep a small wide-mouthed jar full of killed acid on the soldering bench, for if the point becomes dirty or covered with oxide it can be cleansed by dipping it into the acid solution. Some craftsmen dissolve about a heaping tablespoonful of powdered sal ammoniac in a tumbler of water and dip the hot copper into this occasionally in order to clean it.

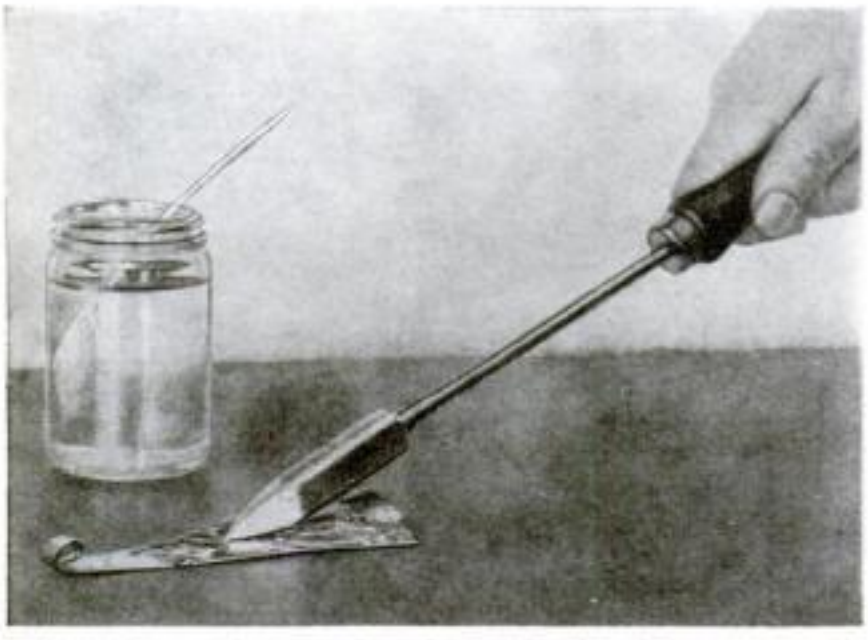


Fig. 3. Remove the copper from the fire and rub each face on a small piece of tin which has been covered liberally with solder and flux.

In soldering a lap joint with the soldering copper, the hot copper is first charged with solder and moved along on the seam as shown in the upper diagram of Fig. 4. Another method, shown in the middle diagram, is to cut solder into small bits and place them along the joint. Both the solder and joint are covered with flux. The soldering copper is placed on the first bit of solder and rested there until the solder melts into the joint; then it is moved along to the pellet next in line, and so on.

Still another method (shown in the lower diagram of Fig. 4) is to hold a length of wire solder against the copper as it is moved along the joint.

Never hold work to be soldered in an iron vise or allow it to lie flat on any metal, as the heat will be drawn too rapidly from the copper and the work. If the work must be supported, place it on wood or asbestos, or use a carpenter's wooden hand screw to hold the joints together.

As to fluxes to be used, copper and brass may be soldered with a borax flux like silver and gold. Steel and even cast iron sometimes can be soldered with soft solder if they are first tinned by fluxing them with killed acid and then covering them with a coat of solder rubbed on with a hot soldering iron. Galvanized iron and zinc are fluxed with pure muriatic acid, while soldering paste or lard oil is sometimes used as a flux for lead. For convenience in soldering small delicate work, self-fluxing wire solder can be obtained with an acid core. In electrical work, rosin is used as a flux, or rosin-core wire solder is employed.

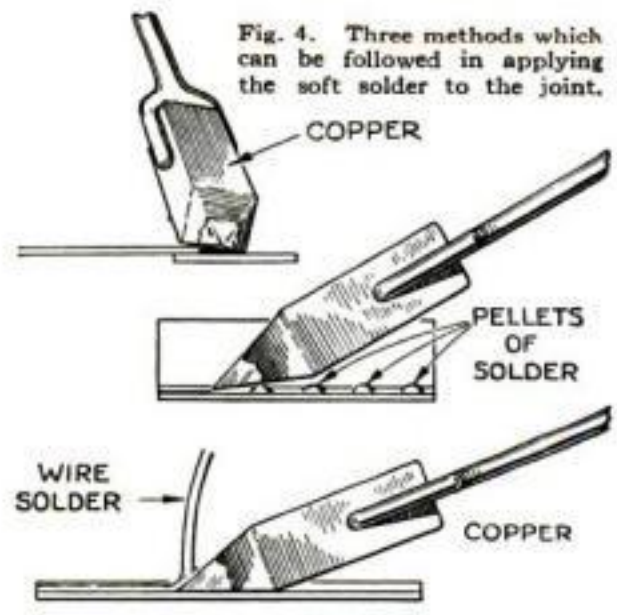


Fig. 4. Three methods which can be followed in applying the soft solder to the joint.

One important precaution in soft soldering is never to heat the copper to a red heat, as this will burn off the tinning and oxidize and pit the working point.

Useful Kinks for the Car Owner

IF THE car is kept in an unheated garage, a motor cover arranged as shown in Fig. 1 will promote easy starting in many cases. Of course it will do no good if the car is not used for days at a time, but if it is operated daily, enough heat will remain in the motor overnight to make it start easier. Use a wooden frame from which to suspend a very thick hood cover made of old blankets and quilting. The counterweight should be heavy enough so that the cover will stay either down or up as desired; in other words, it should exactly equal the weight of the frame and the hood cover.

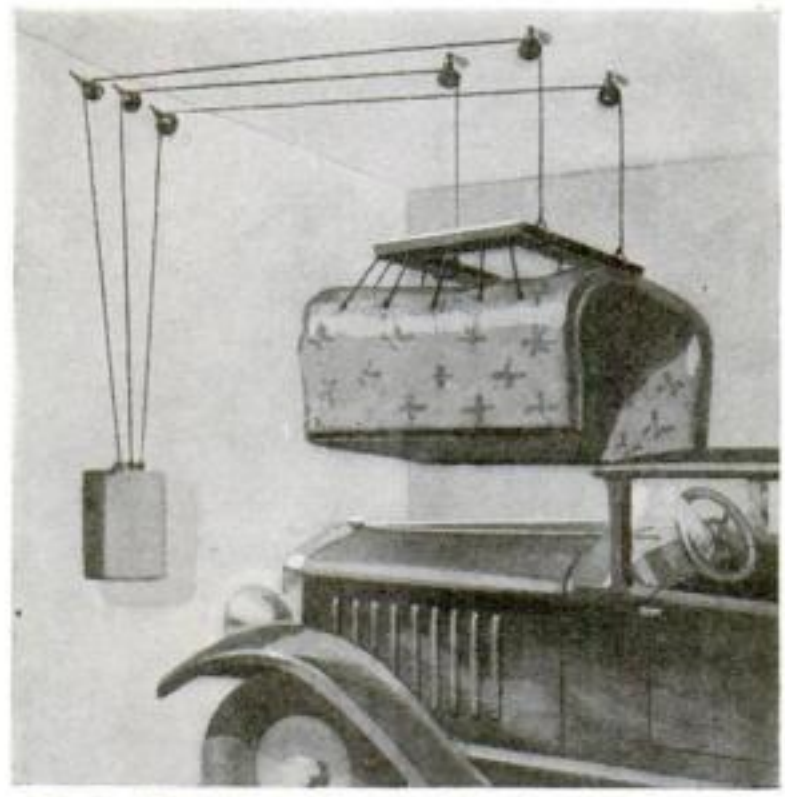


Fig. 1. When the car is put to bed, this thick hood quilt, lowered from the ceiling as shown, keeps the engine warm.

Insulating the Floor

Figure 2 illustrates a simple and inexpensive way to insulate the floor and help to keep the car warm. Sheets of corrugated cardboard cut from large packing cartons should be cut the right size using the floor mat as a pattern. Two or more layers will prove effective as heat insulation and, in addition, the noises that get into the closed body by way of the floor boards will be very noticeably reduced.

A Tin Can Cut-Out

An easily built and effective motor cut-out can be constructed from an old in can and other discarded parts, as shown in Fig. 3. Remove the exhaust pipe and cut a large hole in it. Cut holes in the ends of the tin can so that it will slip over the pipe. Fit one bolt as a stop and another for the spring that pulls the can back over the hole when the valve stem on the end of the cord is allowed to slide into the hole in the dash. The hole in the exhaust pipe can be cut most easily by sawing a V-shaped notch in the pipe with a hack saw. Notch area should equal pipe cross section.

Each month POPULAR SCIENCE MONTHLY awards a prize of $10, in addition to regular space rates, for the best idea sent in for motorists. This month's prize goes to A. E. McCall, Seven Springs, N. C., for his suggestion for a tin can cut-out (shown in Figure 3) for a motor.

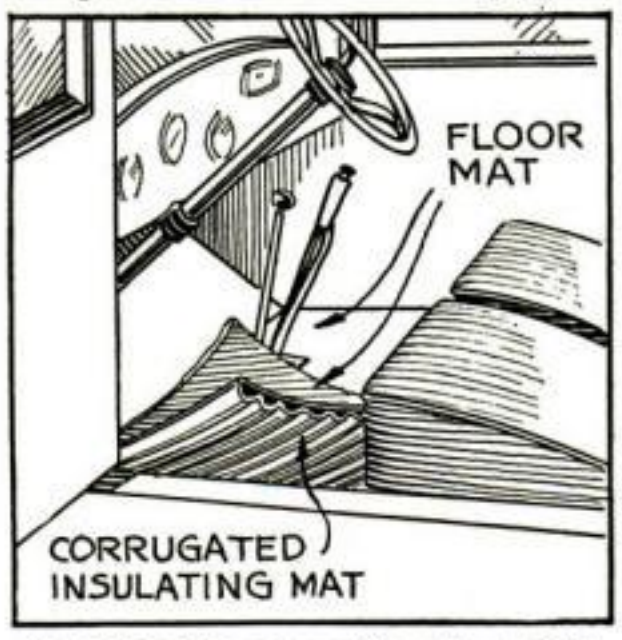


Fig. 2. Insulating corrugated cardboard fitted in place under floor mat keeps the car warm.

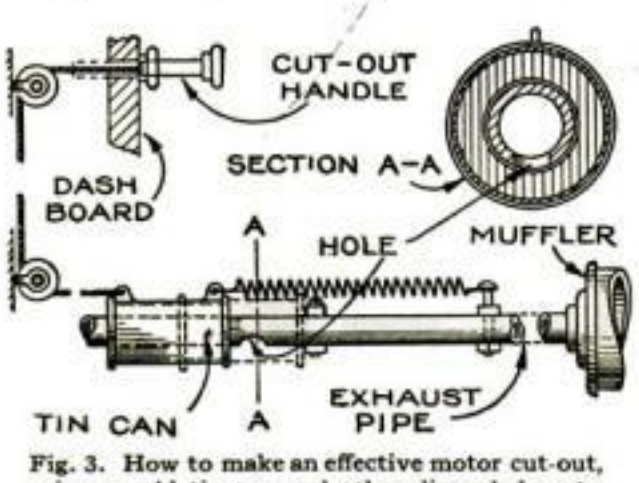


Fig. 3. How to make an effective motor cut-out, using an old tin can and other discarded parts.

A Carburetor Control

Considerable gas can be saved by keeping the carburetor set to the thinnest mixture that will give steady running. The hand control shown in Fig. 4 makes this possible. It is made from a discarded speedometer shaft, a brass collar, and a brass wheel from a toy construction set. The collar couples the lower end of the shaft to the needle valve and the brass wheel serves to turn the upper end.

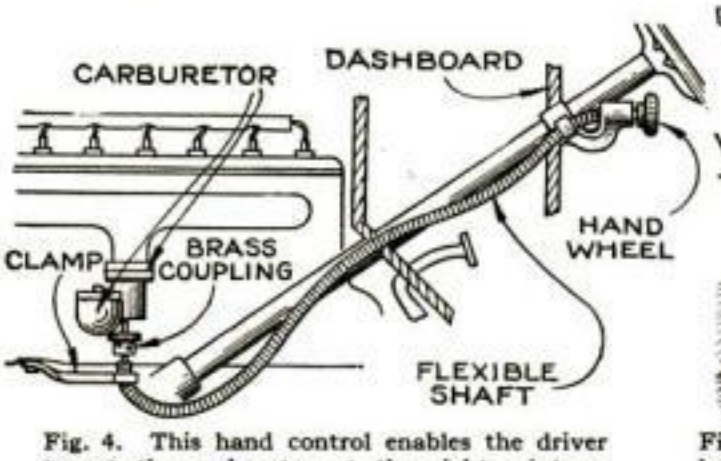


Fig. 4. This hand control enables the driver to set the carburetor at the right mixture.

Getting Out of a Rut

In localities where dirt or gravel roads are common, deep ruts with perpendicular sides will form during the freeze-and-thaw period of late winter. When one motorist meets another, both traveling in the same set of ruts, a pair of wedge shaped blocks, shown in Fig. 5, will facilitate climbing out to make passing possible. Size and angle depend on local conditions. Thin boards nailed together can be used.

Automatic Garage Light

A stop-light switch fastened to a beam and connected into the light circuit as shown in Fig. 6 will provide an automatic light for the garage. When car drives into the garage its front wheels switch on the light at the ceiling. A cord to the lever of the stop-light switch should be fastened to a board hinged to the floor in such a way that the front tires rolling on to it will pull the switch to the on position. A push button switch is included in the circuit, of course, to provide a ready means of turning off the light. If the weight of the board will not allow the spring to pull the switch up to the off position, use a suitable counterweight.

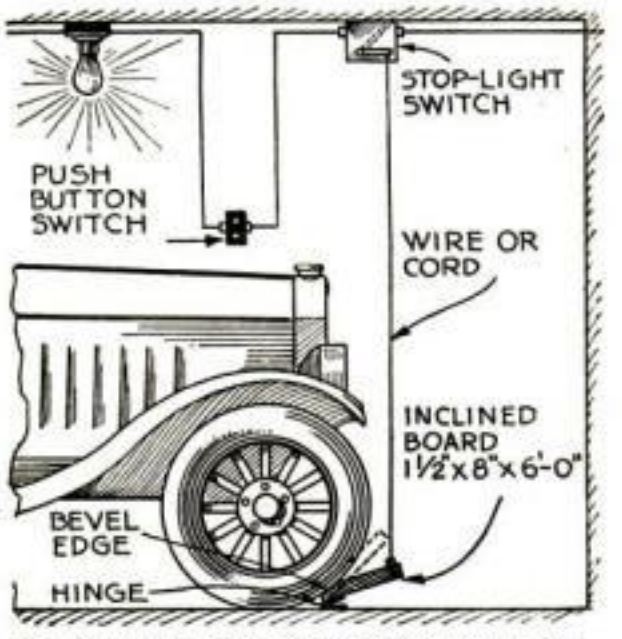


Fig. 6. When the car rolls into the garage, the front wheels turn on the electric ceiling light.

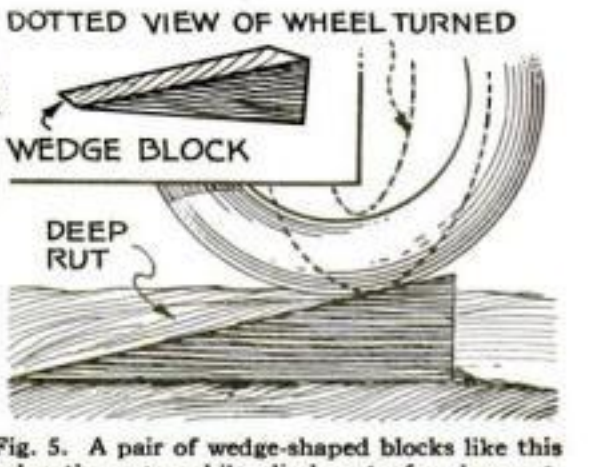
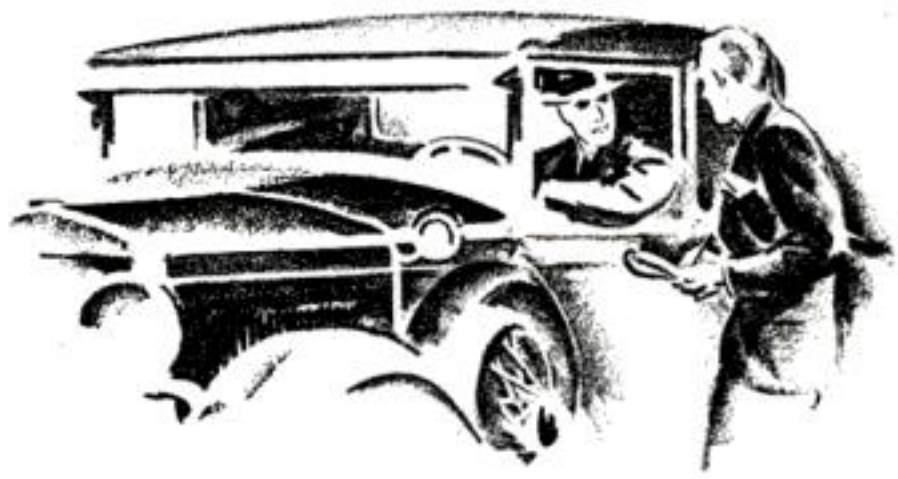


Fig. 5. A pair of wedge-shaped blocks like this helps the automobile climb out of a deep rut.



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GARGOYLE

The author at work assembling the body of his *Diamond Tally-Ho* stagecoach model.

Building the Body of the *Diamond Tally-Ho*

By EDWIN M. LOVE

AFTER long research and study, POPULAR SCIENCE MONTHLY, for the first time in the history of model building, is presenting its readers with authentic plans for the construction of a model stagecoach.

WHILE the trail-worthiness of the *Diamond Tally-Ho*—that famous old stagecoach which years ago swayed on leather springs and rocked back and forth in rhythmic fashion over the rough road from San Diego to the small town of Julian in California—depended on the sturdy construction of the carriage, all the romance of gold mining days was symbolized in its brilliant vermilion body. It is this colorful body that makes the model of the coach so picturesque an ornament.

With the completion of the carriage (P. S. M., Feb. '30, p. 77), we come to the construction of the body and the means of supporting it.

Three blueprints with full size drawings (Nos. 115, 116, and 117) have been prepared for those who wish additional details of construction (see page 108).

BRACKETS. *Front:* Anneal a 7-in. length of 1/16 by 1/4 in. brass and fold it in the middle around a No. 14 escutcheon nail, pinching the loop close to the pin. Bend the upright, shape the legs to fit over the bolster, and cut it to length. The third bolt lug is added in plastic wood which is carved to shape after it dries. Rivet this to the bolsters with No. 16 escutcheon pins placed so their heads are to the front.

The horizontal S-shaped braces are made of No. 11 copper wire and have eyes on the ends.

Copper wire (No. 8) is used for the oblique brace, and is split at one end so that it will spread into the fork that clasps the perch. The other end is flattened and drilled for a No. 14 pin which passes through the upper braces, the cross member, and the lower S-shaped brace and has a nut riveted to its end.

The step plate, which is made of No. 14 sheet metal, is filed thin on the edges and soldered to the flattened end of a piece of No. 11 copper wire. The other end of this wire is flattened and soldered to the outside of the perch. The other perch is made in a reverse manner.

Rear Brackets: These are bolted to the rear bolster and axle. A long eye on the lower S-shaped brace is held beneath the axle end with two bolts and covers the clip joint.

Clevises: Make four for the suspension straps by hammering No. 14 sheet metal to a thickness of 1/32 in.

BODY. *Sides:* Make a cardboard pattern indicating the outline of the side, door, and windows. Trace the outline on a piece of 1 1/4-in. sugar pine placed so that the grain is vertical. Square the ends of the door lines across the top and bottom edges so that they can be located after carving.

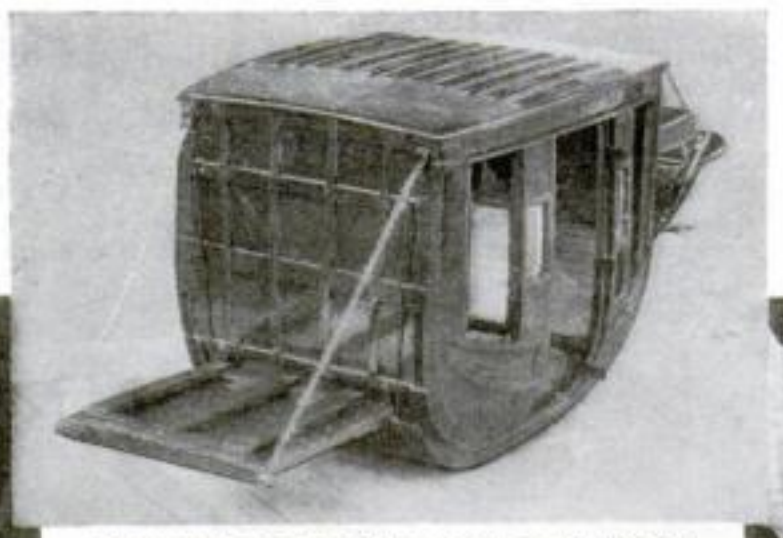
Prepare a vertical center section pattern to trace on the ends, and a horizontal section for maximum bulge and for the top outline. Also gage the ends with a setting of 13/16 in. from the front.

Carve the vertical outside curve, working across the width with a wide chisel and smoothing the surface with a jack plane. Next, cut down the ends for the horizontal curve and smooth to an even curve in all directions, thus forming the top curve.

After the inside has been hollowed out cut a 1/8 by 1/8 in. rabbet on each end, squaring it with the chord of the horizontal curve so as to receive the end pieces.

In the original *Diamond Tally-Ho* the small sashes were raised into recesses above their openings. Carve these recesses, leaving a 1/16 in. thickness of wood outside and groove the window posts with a veining gouge to receive the edges of the sashes.

Draw in the panels on the side; a thin stick sprung around suitably driven brads will aid in drawing these lines smoothly. Carve the pointed panels under the large windows to a concavity of 1/16 in. at the center and taper them off to nothing at the edges. At opposite corners of the doors bore 1/8-in. holes and cut out the door openings with a coping saw. Fill the notches left by the holes with plastic wood and smooth the edges of the posts and the doors. Glue the doorstops flush with the front, post stops flush with the in-



Above: The completed stagecoach body with the front and rear platforms attached. Note the three imitation hinges projecting from the door jamb.

Left: Use of the block plane and bench hook in smoothing the body sides. Right: The pointed side panels are cut to a depth of 1/8 in. in the center portion and taper out to nothing at the edges.

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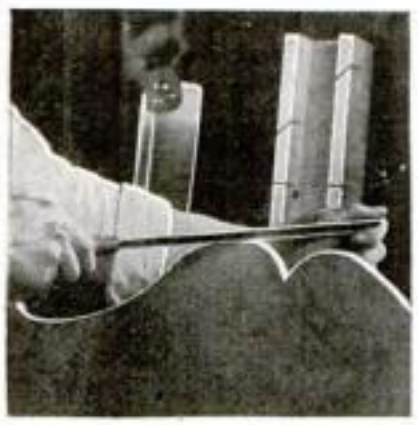
Coiled spring-steel ferrule holds tang of file tightly, prevents slipping. File removed and replaced readily without injury to handle, which may be used repeatedly. Comfortable grip lessens wrist-strain, and helps to make the amateur a better filer.

To introduce this improved file handle quickly, Disston will send one direct to you by mail, with "The Disston Saw Tool and File Book," for 10 cents. Ready Feb. 15; your hardware merchant can supply them soon afterward. Mail the coupon now.



Files for the Wood Worker

Disston Cabinet Files (fine teeth) for smoothing and finishing wood surfaces, easing tight doors and drawers, etc. Disston Wood Rasps (coarse teeth) for rough and fast cutting, enlarging holes, etc. Half-round 8" Cabinet File, 65c. Flat 8" Wood Rasp, 50c.

Disston No. 2 Stronghold File Handle. Length 4½". Four other sizes made.

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $3.45. Many other styles and sizes to choose from.

Files for the Metal Worker

Every kind, size and style. A Disston 8-inch Mill File, bastard cut, is fine for sharpening axes, lawn mowers, garden tools, and general work in the home and shop. Excellent for finishing metal surfaces. 25 cents each.

FOR best results, use Disston Files in Disston Stronghold File Handles. Disston Files are the only files made of Disston Steel, the world's great cutting steel, which adds stamina, toughness, and long cutting life to every Disston Saw, Tool and File. The daily use of Disston Files, by Disston saw-makers, safeguards the quality of *all* Disston Files.

You will find a Disston File still cutting true, long after another file would be useless. Far longer service, mechanics say, and better service *always*. Hard, tough, keen, true cutting!

For fast cutting, use Disston bastard double-cut hand, flat or half-round files. For a fine finish use Disston single-cut mill or taper files. For filing your hand saws, you will want to use Disston Special Extra Slim Blunt Saw Files. Hold file firmly against metal to be cut.

Allowing file to slip dulls it quickly. Cut on forward stroke, use full length of file, and lift file slightly on return stroke. To control the cut, hold thumb of left hand at point of file. For fast cutting, rest ball of left hand on file. Keep file free from chips by using a file card and brush. Oil file after using, to prevent rust.

Coiled spring-steel ferrule holds file tightly.

Note slits compressed by ferrule.

Disston makes files for every purpose, sold by good hardware merchants everywhere. Ask for Disston! Not only files, but also hand saws, circular saws, and every other type of saw for hand and machine work; hack saw frames and blades, etc.

Band Saws for Better Work

Disston "Thin Gauge" Narrow Band Saws are 2 to 3 gauges thinner. They run better on machines with wheels up to 26" diameter. Saw 9' 8" long, ½" wide, 25-gauge, brazed, $2.03. Other sizes in proportion.

Hints on Using a Hack Saw

For cutting pipes, bolts, nails, curtain rods, etc. Strain blade tight. Cut on forward stroke. Disston No. 36½ Hack Saw Frame takes 8" to 12" blades. $2.10. Blades, 8", 55c doz.; 10", 65c doz.; 12", 75c doz.

For Your Power Saw Outfit

Disston Saws insure better work. Cut easier, stay sharp longer. Disston Circular Saws —cross-cut, rip or combination—are made to fit any make of machine. If your dealer cannot supply you, write to us for prices.

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Makers of "THE SAW MOST CARPENTERS USE"

Mail the coupon at the right, with a dime or stamps, and get the new Disston No. 2 Stronghold File Handle, 4½" size, and "The Disston Saw, Tool, and File Book," an illustrated manual on the selection, care and use of tools, full of helpful information.

Henry Disston & Sons, Inc., Philadelphia, U.S.A.
(In Canada, address Henry Disston & Sons, Ltd., Toronto, Ont.)

For 10 cents, enclosed, send Disston File Handle and Disston Book to:

Name and Address.....

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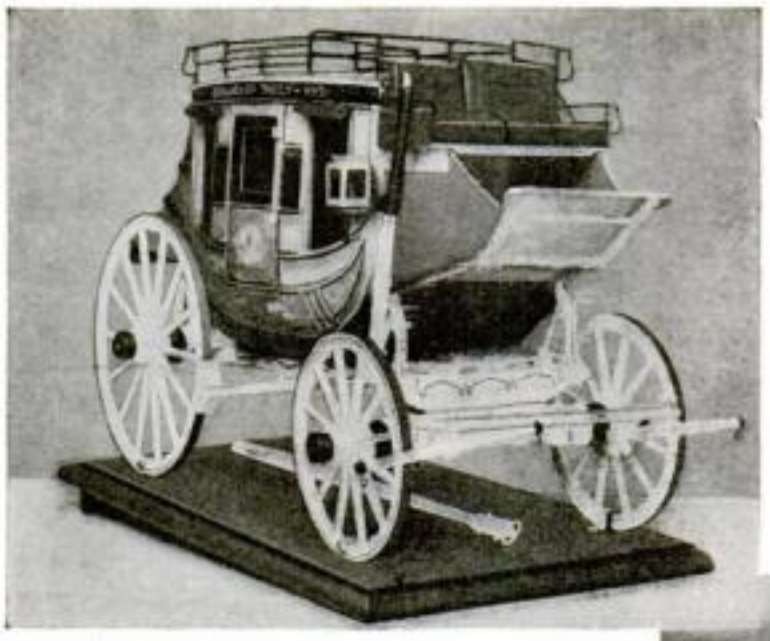
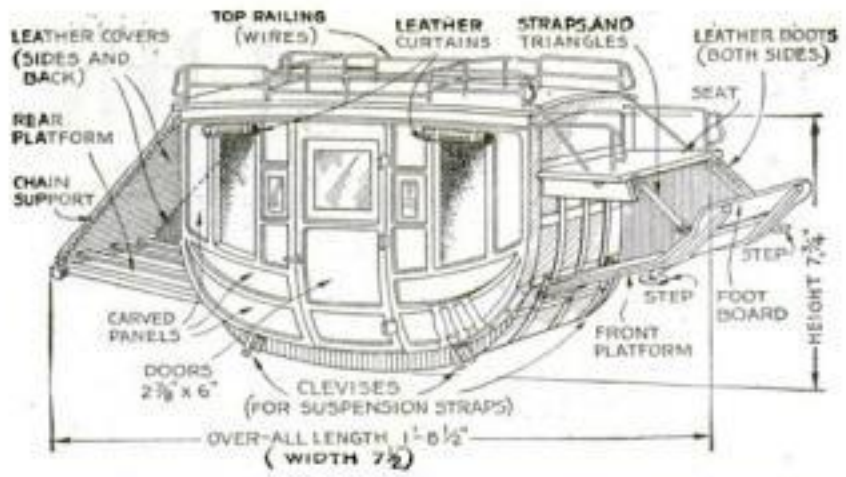
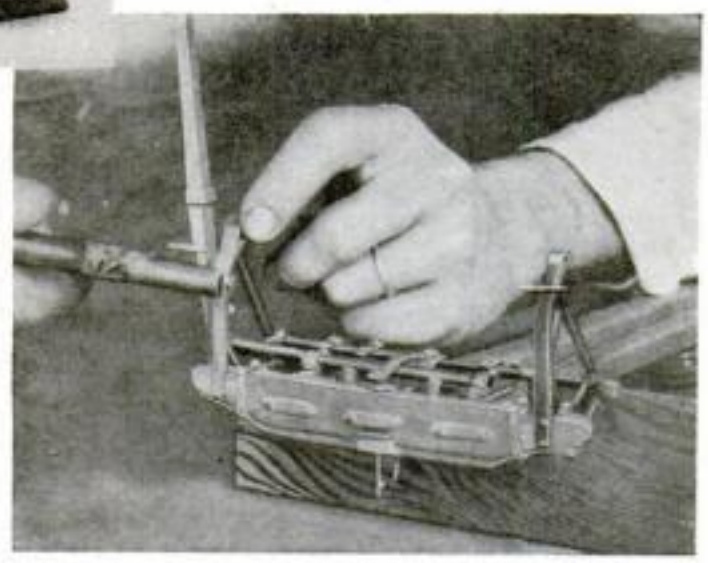


The completed coach and its base form an attractive and colorful ornament for the home.



Perspective of the coach body showing the general construction of the platforms, seats, doors, and wire railing on the top.



Attaching the footsteps to the metal brackets which hold the ends of the strap leather suspension springs.

side, and put the upper stops in place.

The rabbeted sides are made of ⅛-in. maple, two pieces to each side and placed so that the grain of the wood follows the curve. Glue the sides in place with waterproof glue and allow to dry thoroughly.

BOTTOM AND ENDS. These are made of ⅛-in. pine placed so that the grain runs crosswise on the cab. Assemble the sides with temporary cleats on the edges. Wet one side of a piece of ⅛-in. stock to make it pliable, rest the rabbet sides on a prop held in a vise, and nail the bottom in place, wet side out, using ½-in. No. 20 brads and drilling part way with a No. 60 drill. Attach the ends in the same way.

Glue muslin on the ends and sides above the upholstery, except in the recesses above the small sashes.

TOP. The top is made of ½-in. stock and is held in place with brads. Trace the shape from the body, allowing a 3/16-in. projection all around, shape the outside, fit the inside to the body, and glue muslin on the underside before placing it.

PANEL BARS. These are strips of 1/16-in. cardboard glued in place. When the glue is dry, give them two coats of shellac and cut the edge bevel. The band beneath the name space is double thickness at the center but tapers at the ends to one thickness.

MISCELLANEOUS. To support the seat cushions nail a maple rail between the sides, 1 3/16 in. from the door openings at each end and with the upper edges 1½ in. above the floor level at the center.

The door hinges are maple strips notched into the posts with their joints in a straight line. The door is set around them, fitting closely enough to stay in place. Attach the platform hinges with brads clinched on the inside.

PLATFORMS. *Front:* The supporting bars and footboard are made of maple, while the rest of the sheathing is made from ⅛-in. pine. A half-round bar covers the footboard joint beneath; and a curved one, which is thicker at the back than at the front edge, covers the top. Add the two step irons with the strap eyes, glue thin cardboard straps above and below, and put the bolts and nuts in place.

Rear: This is made from ⅛-in. pine and has 3/16 by 3/16 in. bars forming the frame. The rear end bar projects 3/16 in. beyond each side and has round ferrules made of thin metal or cardboard. Drive ¾-in. brads through from below, and bend them into eyes to accommodate the chain hooks. Two cross braces made of thin metal, and the 3/16-in. No. 14 hinges made by bending an end around a brad, are added next. The top frame is made up of two 3/16 by ⅜ in. crossbars with three ⅛ by ½ in. bars glued lengthwise. A thin cardboard strap is bolted in front and along each side.

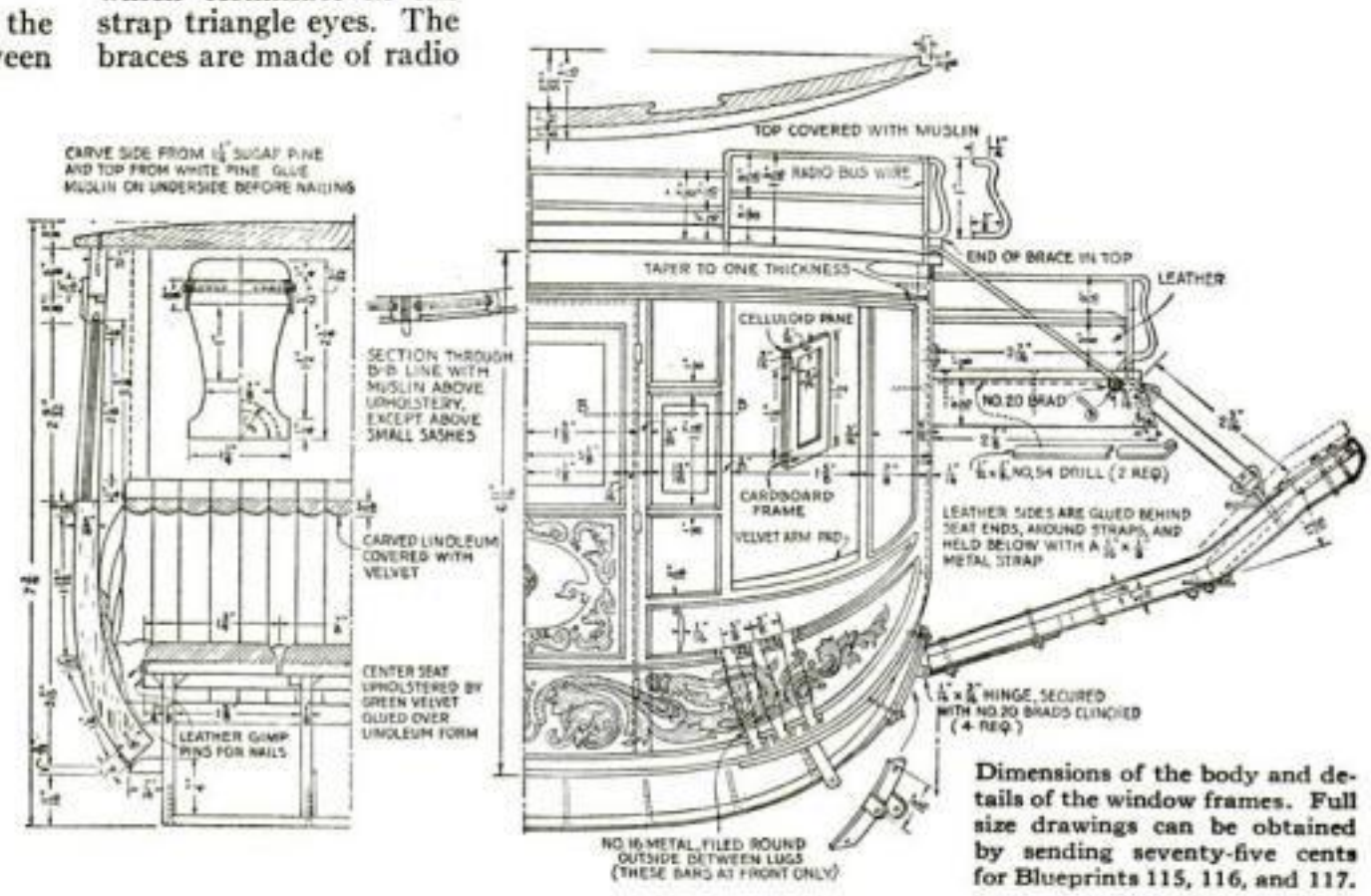
SEAT. Drive brads through the maple seat board and into the ends, and from the inside of the body into the seat and ends. Underneath, and inside the ends of the seat, glue the metal strips which terminate in the strap triangle eyes. The braces are made of radio bus wire and have eyes at the lower ends. Brads headed with nuts are driven through these eyes and into the ends of the seats. The upper ends of the braces hook into holes placed in the roof.

TRIANGLES AND RINGS. Wind wire on a rod of the size and shape desired, and cut through one side of the turns, preferably with a jeweler's saw. To open a triangle or ring, grasp it with two pairs of pliers and twist it sidewise. To close, reverse the operation.

Next month we shall complete the directions for building the *Diamond Tally-Ho* by giving suggestions for upholstering and decorating the model, along with instructions for providing the miniature stagecoach with an attractive mounting.

All of the carriage building terms which are not self-explanatory are clearly marked on Blueprints Nos. 115, 116, and 117, which contain complete, full size drawings. In making so complicated a model as this, full size drawings are essential.

Plans for a picturesque covered wagon and for other coaches will be prepared if readers are sufficiently interested in models of this type. What is your particular preference—a covered wagon, another coach, a one-horse chaise, a Mexican oxcart? If you prefer to build ship models, please mention the specific ships or class of ships for which you wish plans. Address correspondence to the Home Workshop Editor, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York.



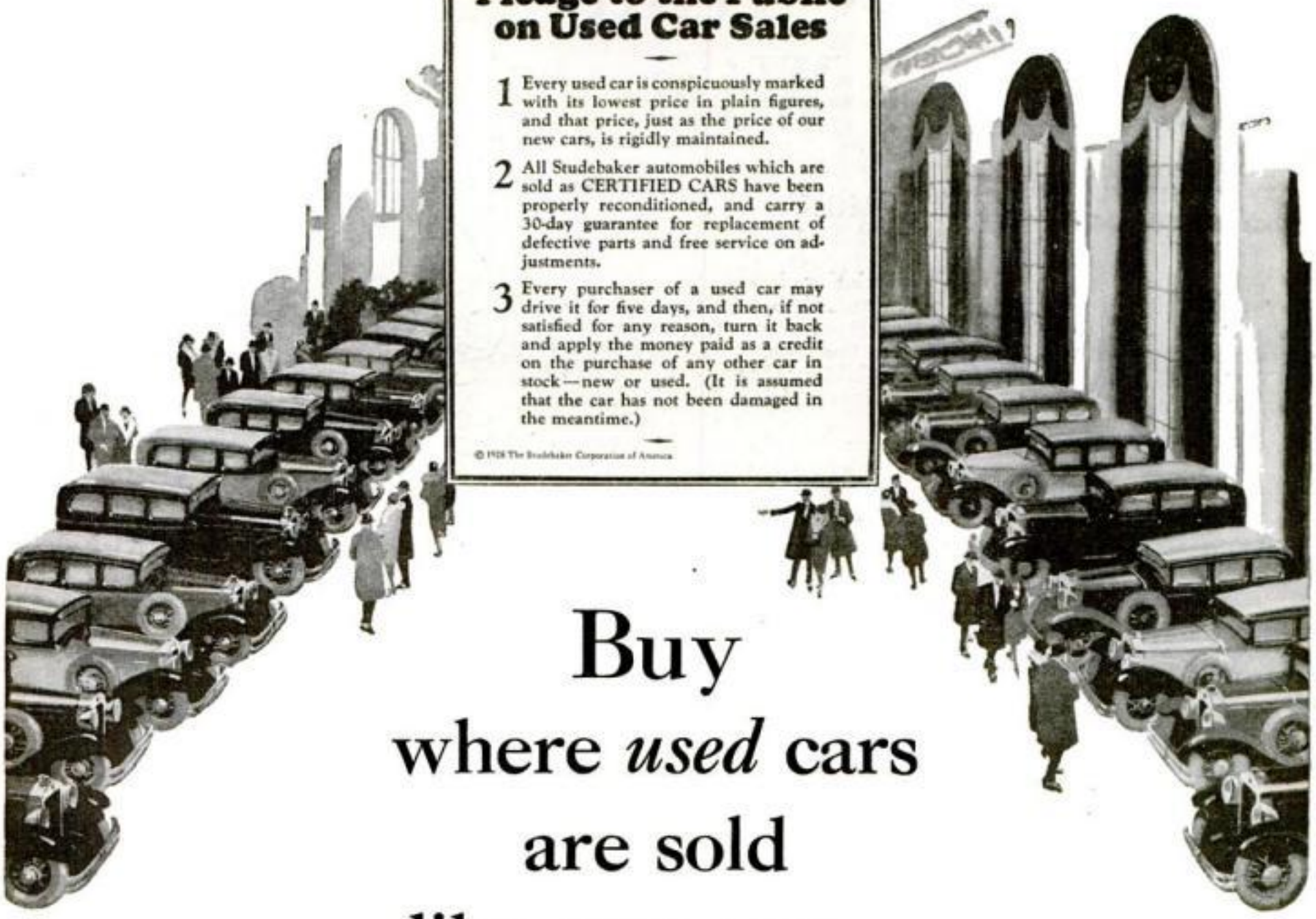
Dimensions of the body and details of the window frames. Full size drawings can be obtained by sending seventy-five cents for Blueprints 115, 116, and 117.

Pledge to the Public on Used Car Sales

1 Every used car is conspicuously marked with its lowest price in plain figures, and that price, just as the price of our new cars, is rigidly maintained.

2 All Studebaker automobiles which are sold as CERTIFIED CARS have been properly reconditioned, and carry a 30-day guarantee for replacement of defective parts and free service on adjustments.

3 Every purchaser of a used car may drive it for five days, and then, if not satisfied for any reason, turn it back and apply the money paid as a credit on the purchase of any other car in stock—new or used. (It is assumed that the car has not been damaged in the meantime.)



Buy where *used* cars are sold like *new* cars··· on the

STUDEBAKER PLEDGE PLAN

NOWHERE in the used car market will you find a fairer, squarer basis for used car sales than the famous Studebaker Pledge Plan. More than 150,000 people, appreciating this fact, bought Pledge-backed used cars last year.

When you buy a Pledge-backed used car, you invest in unused transportation. Most cars sold on this plan have been repainted, refinished and reconditioned to look and perform as well as they did when new.

Under the terms of the Studebaker Pledge, you get five days' driving trial to determine for yourself whether or not the used car you select is suited to your needs. On all Certified cars, the Pledge provides a 30-day guarantee for free adjustments and replacement of defective parts. And all Pledge-backed used cars carry plainly marked price tags—one price to every buyer! Your Studebaker dealer can show and demonstrate Studebakers, Erskines and other makes of cars in a variety of models. You will find the type of motor car you want—and the kind of protection for your purchase that your business sense demands.

Invest 2c—you may save $200

Mail the coupon below for the free booklet. A 2c stamp is an investment which may save you as much as $200 in buying a motor car!

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STUDEBAKER

Builder of Champions

Twenty-Five Hints on Using Wire

By HENRY SIMON

A piece of wire coil spring can be used as a core to facilitate the bending of lead pipe or thin metal tubing.

WIRE, through proper handling and intelligent choice of form, can be used to solve many difficult problems in the shop. Its physical characteristics make it a suitable material for use as tension, torsion, and compression members, and for many other purposes which to most of us are less evident.

The common metals from which wire is drawn are steel, copper, brass, and aluminum. Wire is made in dead soft, half-hard, and hard tempers. This must be borne in mind at all times, as the possible uses of different forms of wire depend on their degree of temper. Many things can be easily made from one temper of wire that would be altogether impossible to make from others. Half-hard wire, for instance, is often useful because it can both be readily shaped and will retain the shape it has been given even under considerable amount of stress. The approximate bending radii for the different tempers are shown in Fig. 1 at *B*.

Annealed steel wire, especially of the baling wire variety, offers the valuable combination of dead softness with a high degree of toughness, together with the fact that it can be set in the final form by heat treatment. This heat treatment may be of two kinds—stiffening by simply quenching the heated piece in water or in oil, or casehardening, as suggested respectively at *A* and *B*, Fig. 2. For casehardening, it suffices to dip the heated piece into powdered cyanide or hardening compound, and then to soak it at the quenching heat for the amount of time as designated in the table in *B*, Fig. 2. These values will give a case which will be correct proportionally to the thickness of the wire and thus will prevent brittleness. With high temper steel wires, heat treatment cannot be attempted, as the strength of these wires, obtained as it is by cold working in the drawing operation, is destroyed by heating, and cannot be restored.

AN INTERESTING comparison of the strength of various steel wires is shown in the graphic chart in Fig. 2 at *A*. Many will be doubtful as to the statement that the tough wire used in baling, which retains its strength when sharply bent back and forth a dozen times, should only have about one fourth the strength of ordinary piano wire. The fact is that annealed steel wire has extreme tenacity but low breaking strength, while high temper piano wire has low ductility but enormous strength. Indeed, ordinary piano wire is one of the strongest things in the world for its size. As seen in the diagram, a piano wire 1/16 in. thick will sustain the weight of nearly half a ton before breaking.

The enormous strength of piano wire should from all reasoning naturally fit it for many purposes of suspension and in the application of a pull where rods and bars would be too large, heavy, or expensive. The reasons why it is rarely so used are to be found in the difficulties of satisfactorily fastening and applying the wire so that anything like its strength can be used. The former drawback is overcome by the solder socket shown in Fig. 3, which may be either formed in the part to be pulled as at *A*, or as an independent socket as at *B*. As any good solder melts below 400° F., no part of the strength of the wire is lost in sweating it in place. For a long wire pull, without any appreciable bends or offsets like that shown at *C*, ordinary screw eyes furnish a satisfactory guiding means. Where a considerable angle must be negotiated, a sheet metal, cast metal, or hardwood sheave like that at *D* must be used. Figure 3 at *E* shows an example of a tension device, serving to keep a pull wire taut when it is in the idle position.

A socket similar to the one just described will transmit the entire actual strength of piano or plough wire, and is practically the only fastening that will. Cheaper and more conveniently made fastenings are shown in Fig. 4. Though all of them will fail long before any other part of the wire will, they are often more convenient, and far better than the makeshifts usually resorted to. The strongest one is that shown at *A*, in which the end of the wire is ground off to a taper and the wire bent to a flat loop and soldered. A better looking socket, though one not quite so strong, is shown at *B*. Similar to *B* and requiring no solder, but again inferior in strength, is the one at *C*, in which small soft wire takes the place of solder. Finally, a socket requiring no solder is shown at *D*, where the end of the wire is slightly flattened to give a hold in the enlarged portion of the socket. This construction is more quickly made than the solder socket and allows the wire to be readily shortened, though it is not as strong or otherwise as satisfactory.

WITHIN limits, piano wire may also be used for transmitting a push instead of a pull. One well-known example of such a use is brought out in the shutter release used in most cameras. The same idea may be used to advantage in the shop by encasing the wire in a loosely fitting soft brass or copper hollow wire or tubing. The arrangement, with clearances, is shown in Fig. 5 at *A*. The bends must not exceed those given in Fig. 3 at *D*, and the wire should be kept well lubricated at all times. The longer the wire and the greater the total curvature it has to negotiate, the heavier should be the tubing or the more frequently should it be supported, as suggested at *B*. A close-wound piano wire coil spring, as at *C*, is a good alternative for the tubing and requires no lubricant. As indicated in diagram *D*, such a wire push device can sometimes be used to eliminate a complicated lever system, in addition to forming practically no external obstructions.

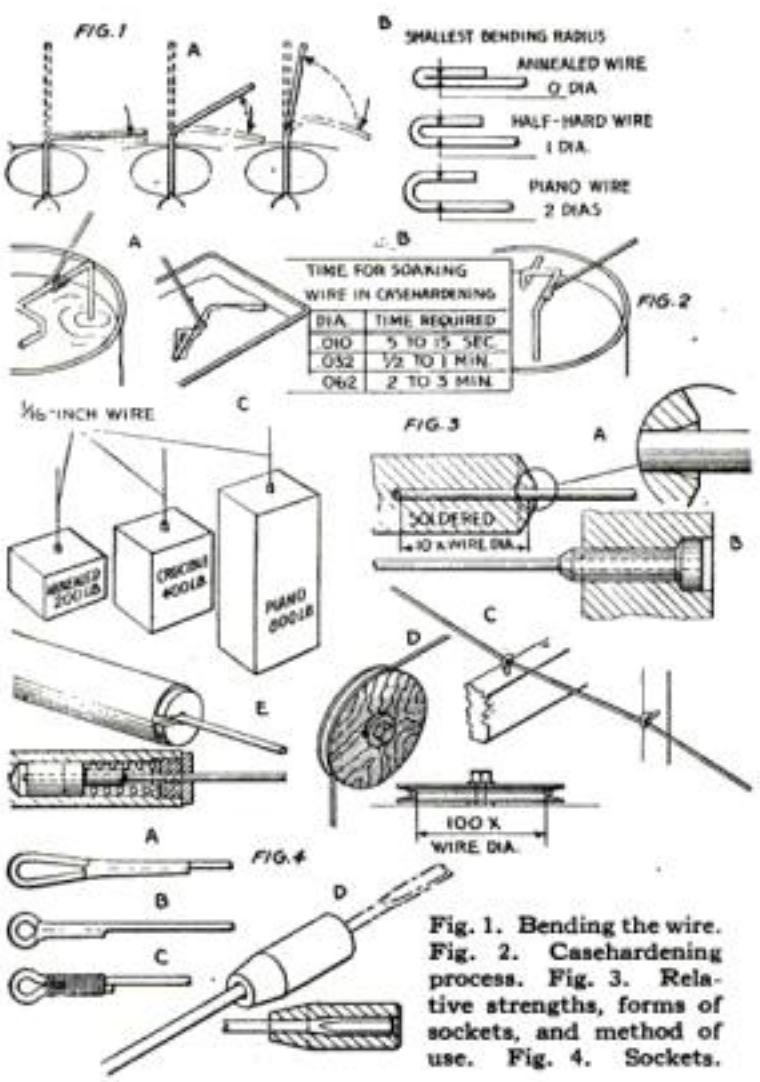

Fig. 1. Bending the wire. Fig. 2. Casehardening process. Fig. 3. Relative strengths, forms of sockets, and method of use. Fig. 4. Sockets.

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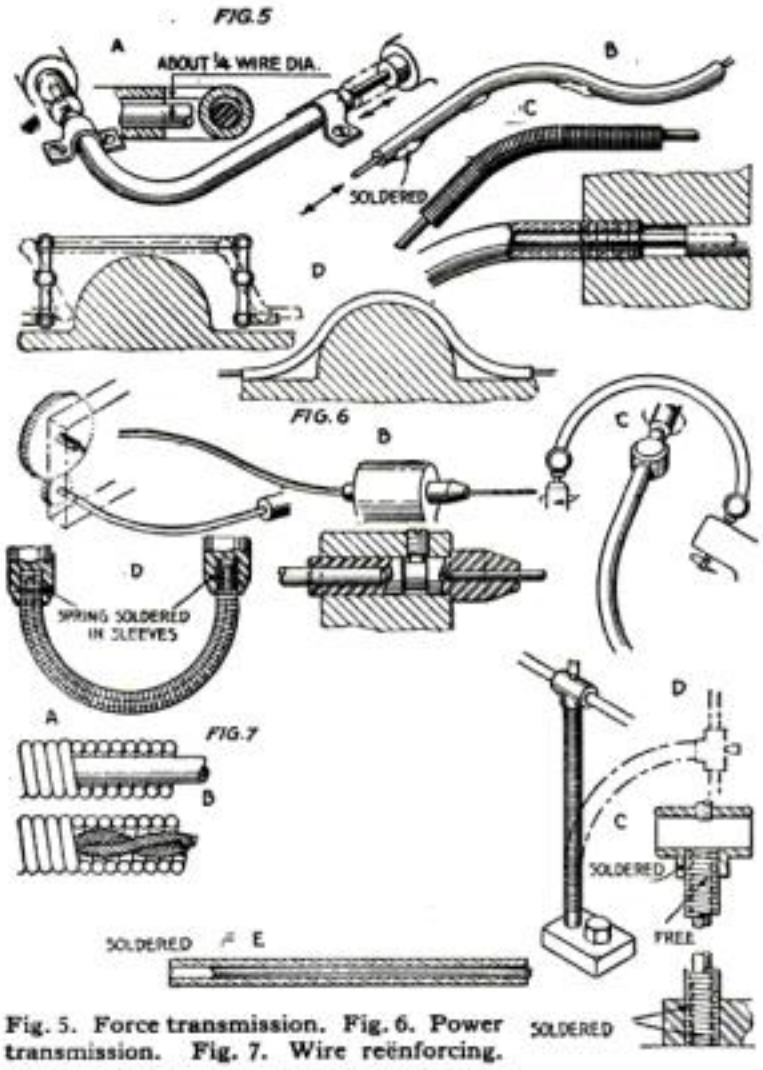


Fig. 5. Force transmission. Fig. 6. Power transmission. Fig. 7. Wire reënforcing.

If piano wire can be used for the transmission of a pull or a push, it is no less suitable for torsion. In the form of a plain wire shaft, it can be used for offset transmission of power for use in small drives, as shown in *A*, Fig. 6, or to drills and reamers as at *B*. With the wire encased as shown in the last figure, the drive can be made to turn heavy curves as at *C* by using either a tube or a coil spring for the casing. On the other hand, matters may be reversed by making a stout close-wound wire spring act as the flexible shaft, while using heavy piano or brass wire as a skeleton in the manner illustrated at *D*. Such a drive has the advantage of requiring none or very little fastening, and also of permitting curves of small diameter to be negotiated, the form of the skeleton wire giving the required support.

Since we have spoken of coil springs for uses other than springs, it may be interesting to mention a few more such uses, lined up in Fig. 7. At *A*, a screen door spring is employed as a crush-proof protection for small rubber hose or metal tubing. It may also be used for making the hose or tubing stand a heavy internal pressure. At *B*, the coil spring serves as armor for an electric cable that must be protected from injury. In the illustration at the top of page 90 it is used as the core for bending lead pipe or thin soft metal tubing. A heavy, dead soft copper wire and a close-wound coil spring, soldered at one end as at *C* and *D*, Fig. 7, make a wonderful combination that can be bent innumerable times to different fixed forms without failure. An alternative combination is a flexible shaft construction similar to that of Fig. 6 at *C*, though with the wire and tube soldered at one end, as indicated at *E*, Fig. 7.

Easily Made Cutter Removes Burrs

BALANCE and weight make the burr cutter shown an efficient accessory for the small machine shop.

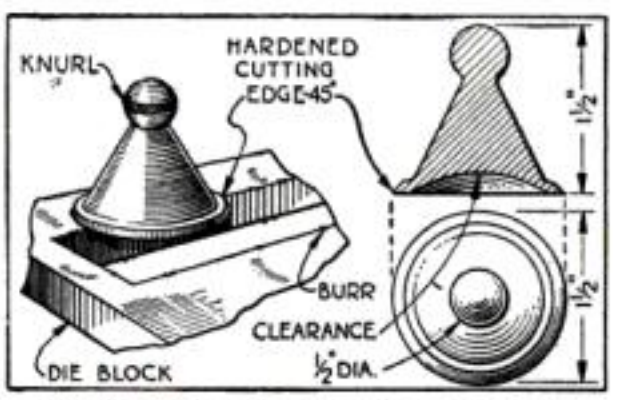
The cutter is easily machined, being circular in shape and having a tapered body and round knurled handle.

The cutting edge is formed at a 45-degree angle and is hardened back far enough to allow ample stock for repeated sharpenings.

The clearance (see illustration) should run back at least 1/16 in. from the edge, and the bottom of the cutter should be ground so that it is absolutely flat and square.

In use the cutter is placed flat on the work and is moved in a sliding circular manner over the burr to be cut. This gives the cutter a shearing action and makes the cutting easy.

The knurled handle and perfect balance of this cutter, together with its weight, makes it easy to operate with a surprising degree of speed and accuracy.—F. J. WILHELM.



The burr cutter has a 45-degree, hardened, cutting edge on its outer circular surface.

Old Bill Says—

MAKE use of every safety device provided in the shop.

Always lift a file on the return stroke; dragging it dulls the teeth and scratches the work.

When melting babbitt, stir in some rosin or oil. This will purify and thin the material and all foreign matter will come to the top.

A man who drills holes in the table of a drill press needs to learn something about running a drill.

Vinegar is a wonderful help in loosening a rusted screw.

Before laying out work, it is necessary to have a definite idea of what the drawing means.

Boring a Taper in a Small Lathe

A SIMPLE and efficient taper boring attachment for use on small lathes can be made with the expenditure of little time and money.

The attachment shown consists of a 1 in. diameter steel bar having a ¼-in. keyway cut along its entire length. A cutter head with a key fastened to its inner surface slides on this bar. The key serves to keep the tool always steady and prevents it from turning.

A ⅜ in. diameter rod is screwed into the cutter head and is bolted to a ⅝ by 1¼ in. block of steel which is fastened in the tool post. This acts as a connecting rod between the tool post and the movable cutter head and makes possible the use of the automatic lathe feed.

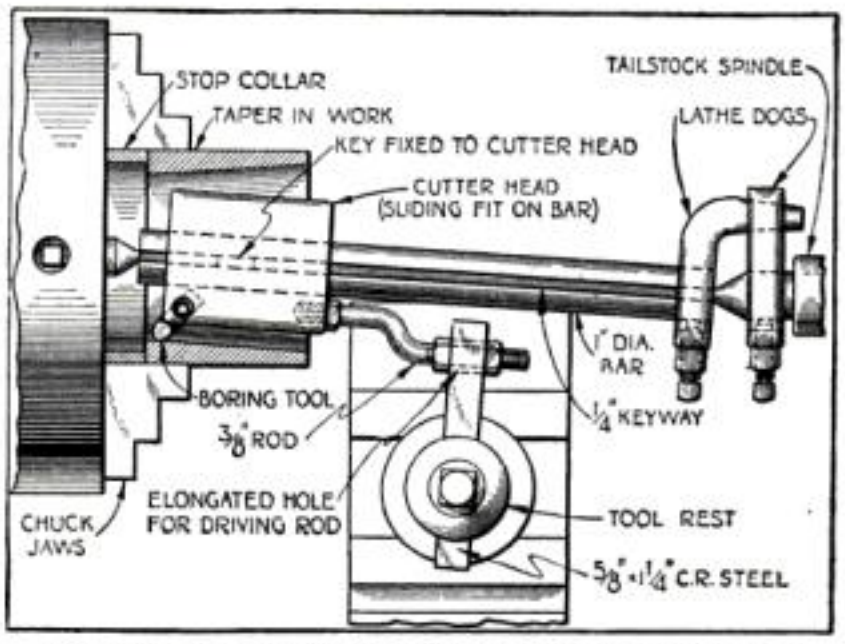
The hole in the block is elongated so as to allow the rod to float as the tool post moves away from the bar during the cutting process.

The work is chucked as shown and the bar and cutter slipped into place and held stationary by the use of two lathe dogs. The tailstock is then set over to suit the required taper and the attachment is ready for use.

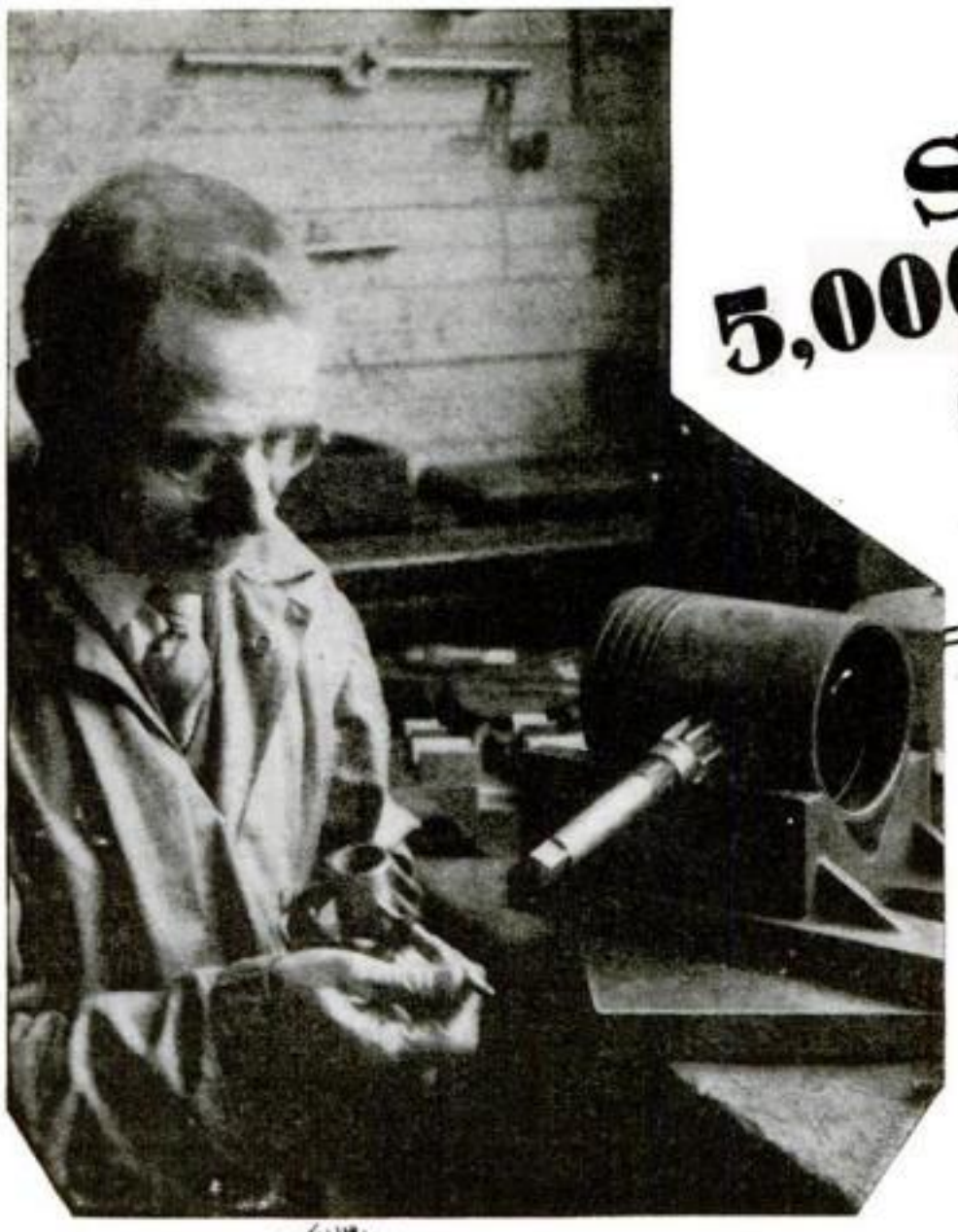
A stop collar is used in chucking the work in order that the taper will start some distance out from the face of the chuck.

A hinged joint may be used on the cutter head instead of the method shown, if desired.

This attachment has been used by the writer with much success and as a matter of fact results have been obtained equaling those of a commercial type taper boring attachment of the simpler type.—CHARLES TOMNEY.



The attachment facilitates the boring of a taper in a small lathe having the offset type of tailstock and no taper attachment.



Schedules of 5,000,000 miles a day depend upon accuracy

LATEST estimates of the total bus miles operated per day in this country approximate five million miles.

This tremendous mileage not only requires accuracy in manufacture but also accuracy in maintenance. Skilled mechanics are constantly checking the performance of every part of the powerful motors that drive these busses. Pistons, crankshafts, camshafts, bearings, wrist pins—all must be accurate if they are to stand the grind of exacting schedules.

And this huge transportation industry is but one of the many important industries where Brown & Sharpe Tools are used in making important measurements. Wherever accuracy is required, Brown & Sharpe Tools are chosen for their reliability and improved designs.

B·S

A copy of our Small Tool Catalog No. 31 will be sent upon request. Address Dept. P. S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

Brown & Sharpe Tools

"WORLD'S STANDARD OF ACCURACY"


Micrometer Caliper No. 24


Screw Pitch Gauge No. 630


Thickness Gauge No. 644


Combination Set No. 438


Steel Rule No. 315

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Tapestry Upholstered Bench

By JOHN M. CHITTENDEN

HOME craftsmen who are wood turning enthusiasts will find the small upholstered bench illustrated an exceptionally attractive spindle turning project. The construction is not too difficult for the beginner and yet has enough character and grace to make it a worth while problem for the expert.

American walnut and Mexican mahogany are well suited for this design, but any wood will serve that is easily turned and that will take a high finish.

The graceful turned legs of this upholstered bench and ornamental stretchers give distinction to the whole design.

The legs are first hand-dressed square. A ⅜ in. thick block 3 in. long is glued to each side 5 in. from one end to form the extra stock for the 2⅜-in. bulge. Make full size templates of one leg and use this in turning the four legs to shape in the lathe.

Lay out the rails, marking all joints on both rails and legs, and bore for the ⅜-in. dowels. Carefully fit the rails and legs together so that each joint is tight, as much of the strength of the bench depends on this part of the construction.

The stretchers can be brought to shape with a hand coping or turning saw or a motor-driven band saw, if one is available. Drill for ⅜-in. dowels and assemble with the 1⅛ by 3 in. square block as shown in the plan at the bottom of this page.

After testing all of the joints, assemble the stretchers, turn the spindle ornament, and complete the construction of the frame.

After all of the superfluous glue has been removed, give the bench a coat of oil stain followed by a coat of dark paste filler. Allow this to dry for at least twenty-four hours and apply three coats of shellac, rubbing the surface with No. 4–0 sandpaper between coats. When the last coat of shellac has dried, apply a coat of wax and rub it in thoroughly.

Stretch three pieces of upholsterer's webbing between the end rails spaced evenly and placed parallel to the side rails. Next, stretch five lengths across the bench, interlacing them with the others. Where one strip crosses another, several stitches should be taken with twine or heavy cord to add to the strength of the seat.

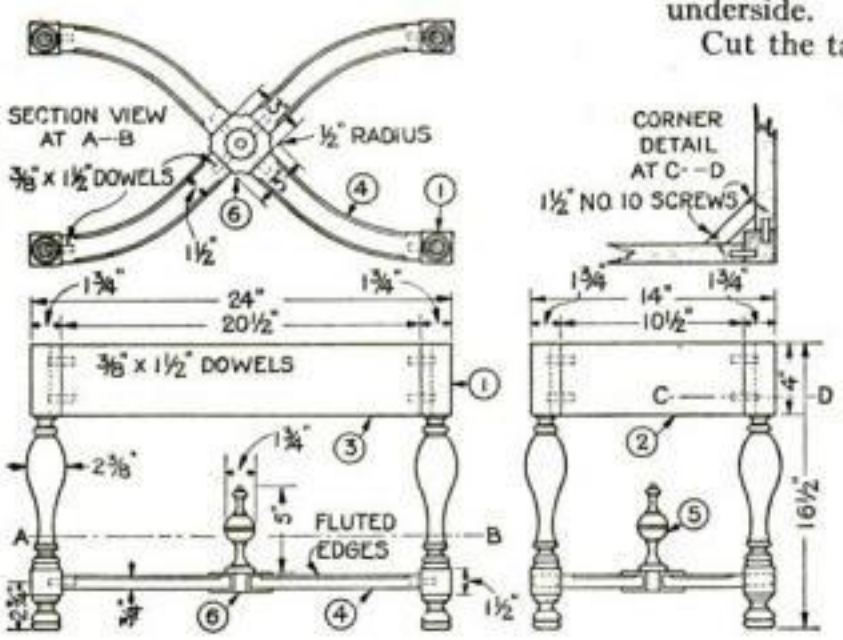
Cover this webbing with an even mat of cotton batting, carefully arranged so as to form a well-rounded seat and to cover all sharp corners on the legs and rails. Over this stretch a piece of muslin and pull it tight around the rails, where it is held in place by driving tacks in the underside.

Cut the tapestry at the corners so that when it is sewed it will form a slip cover 14 by 24 in. and deep enough to cover the rails and allow extra for use in tacking. The bottom of the seat can be covered with a piece of black muslin.

FURNITURE can be washed with a cloth wrung out in castile soap suds. Use little water and dry the furniture thoroughly. Liquid wax is an excellent cleanser, and for especially soiled furniture, liquid cleansers are obtainable.

BILL OF MATERIALS

Mk.	Piece	No. of Pieces	T. in.	W. in.	L. in.
1	Legs	4	1¾	1¾	16½
2	End Rails	2	1⅛	4	10½
3	Side Rails	2	1⅛	4	20½
4	Stretchers	4	¾	3	12
5	Spindle	1	1¾	1¾	5½
6	Block	1	1⅛	3	3
	Leg blocks	16	⅜	2½	3
	Tapestry	1		26	36
	Webbing	7 yd.			
	Cotton batting	2 lb.			



Working drawings. The materials can be obtained for one half or one third the price of a similar bench sold commercially.

Heavy, rough castings are fashioned into machine parts.

Thousands of small and large units are finished to accuracy limits measured by tenths of a thousandth of an inch.

Many types of grinding machines employ many thousands of grinding wheels — reducing and finishing metals at lightning speed.

NORTON COMPANY
WORCESTER, MASS.

NORTON

Grinding Wheels
Grinding Machines

Refractories-Floor
and Stair Tiles

Doctor Finds Home Workshop Restful After Day's Work

One end of Dr. C. B. Calbreath's shop, showing the main woodworking bench, wood lathe, and woodworking machine.

RECREATION in the form of mental and physical play is a necessity in every man's life. No one should be without some hobby, some means of taking his mind from the everyday worries of a commercial or professional career.

The home workshop enthusiast finds mental relaxation in his little shop, tucked away in some corner of the house or hidden in attic or basement. Some shops are large, some are small, but each serves its purpose of supplying the owner with mental play and an outlet for surplus physical energy.

Each day after long hours of caring for his practice, Dr. C. B. Calbreath, of Hastings, Nebraska, spends some time working in his well-equipped home workshop. In a letter which accompanied the photographs shown, he said, "I am a practicing surgeon, and nothing rests me more after a hard day's work than to run down into the basement of my home and work for an hour or so."

In the center foreground of the picture at the top of the page can be seen a combination woodworking machine. This machine can be used as a saw (crosscut or rip), 6-in. jointer, 12-in. planer, hollow chisel mortiser, shaper, emery wheel, dado saw, and disk and cylindrical sanders. The machine is also equipped with a tilt table, thus allowing the cutting of both simple and compound miters.

The wood lathe seen at the extreme right of the above picture has a 14-in. swing and is 6 ft. between centers. This size of lathe allows Dr. Calbreath to do a large variety of work.

The main workbench, which is home-made, has a large maple top, oak legs, and walnut drawers.

By supplying his shop with the large folding tool chest seen in the background of the picture above and by building drawers under the main bench, Dr. Calbreath has been able to provide protection for all of his hand tools and machine cutters.

At the opposite end of the shop from the main bench is a metal working bench, a scroll saw, and a miter box.

IN HIS spare moments Dr. Calbreath has constructed many fine pieces of furniture, among them the large grandfather's clock and the Colonial footstool shown in the photograph below.

The clock case, which was fashioned from solid walnut, stands 7½ ft. high and is 22 in. wide and 18 in. deep. The craftsmanship evident in every line and molding of the clock case clearly indicates the skill with which Dr. Calbreath utilizes his cabinet-making equipment.

The footstool also was made from walnut and is in perfect harmony with the antique design of the clock case.

A walnut grandfather's clock case and footstool made by Dr. Calbreath.

If your home workshop has some unusual features, send a photograph or photographs, accompanied by a brief description of the shop, to the Home Workshop Editor, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York. Five dollars will be paid for each photograph found suitable for publication.

Just a year old...on MARCH 1, 1930

but what a big baby it's grown to be!

WHO ever heard of such an astounding growth in one year? Born March 1, 1929 of distinguished parentage, this promising infant of the Millers Falls family was soon permanently adopted by thousands of experts – carpenters, cabinet makers, craftsmen . . . men who know and use good tools.

On behalf of the truth it must be stated that the Millers Falls Line of Planes started in life with unusual advantages. Months of careful experimentation by capable engineers, years of experience in fine tool making – these were but a beginning. The result was a line of Planes that improved the good points and eliminated the difficulties hitherto experienced.

Chattering – the age old cause of trouble – is done away with in Millers Falls Planes. A new feature in Planes – a 3-point bearing of the lever cap – keeps the cutter flat the entire length of the seat and holds the blade firmly at the correct cutting angle.

Improved plane cutters which need less sharpening and reconditioning are the result of a profound knowledge of fine tool steels and a new process of tempering the cutters electrically. Other improvements include extra reinforcements of the bottoms and frogs and a thickness and width of the lever cap – the most frequent point of breakage – which enables you to clamp the cutter as tightly as you want. The Millers Falls Line of Planes is complete, too – bench planes from 7 to 24 inches, smooth or corrugated bottoms, and 21 models of block planes.

Ask your dealer to show you Millers Falls Planes. He'll take one apart and let you see for yourself the unusual improvements which feature the line and what they'll do for you. We'll be glad to send you a leaflet free of charge showing all the 46 numbers. Write today to Millers Falls Company, Millers Falls, Mass.; New York: 28 Warren Street; Chicago: 9 So. Clinton Street.

MILLERS FALLS TOOLS SINCE 1868

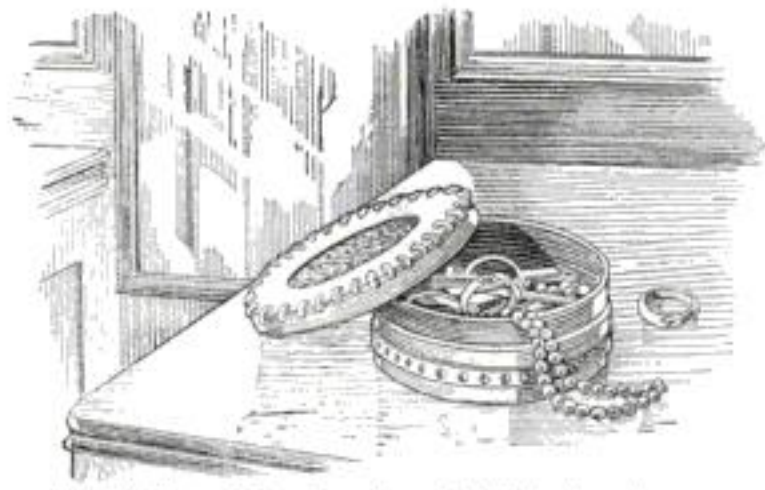
CABLE ADDRESS: MILLERFALL NEW YORK

Ⓢ

MILLERS FALLS TOOLS

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Tooling a Sole Leather Box



This little tooled and embossed leather box forms an attractive container for small trinkets and jewels.

By
F. CLARKE HUGHES

DURABILITY, together with the quality of being worked easily into shape, makes leather an excellent medium for decorative craftwork. A box, such as the one shown, will practically never wear out; in fact, its attractiveness increases with age.

Materials needed in the construction of this box can be obtained from the neighborhood shoemaker. The leather should be obtained in two pieces, one being 3½ by 7 in. for the top and bottom and the other 1¾ by 11½ in. for the sides. When cutting the parts to size and shape, leave the sides a little long to allow for fitting.

The design on the sides may be tooled with a blunt awl or a blunt lead pencil after the leather has been softened by wetting it in a pan of warm water. A number of designs of simple form which might be used for these sides are shown (upper right-hand corner of drawing).

A die made from a piece of heavy linoleum is used to emboss the lid. (See P. S. M., Nov. '29, p. 102.)

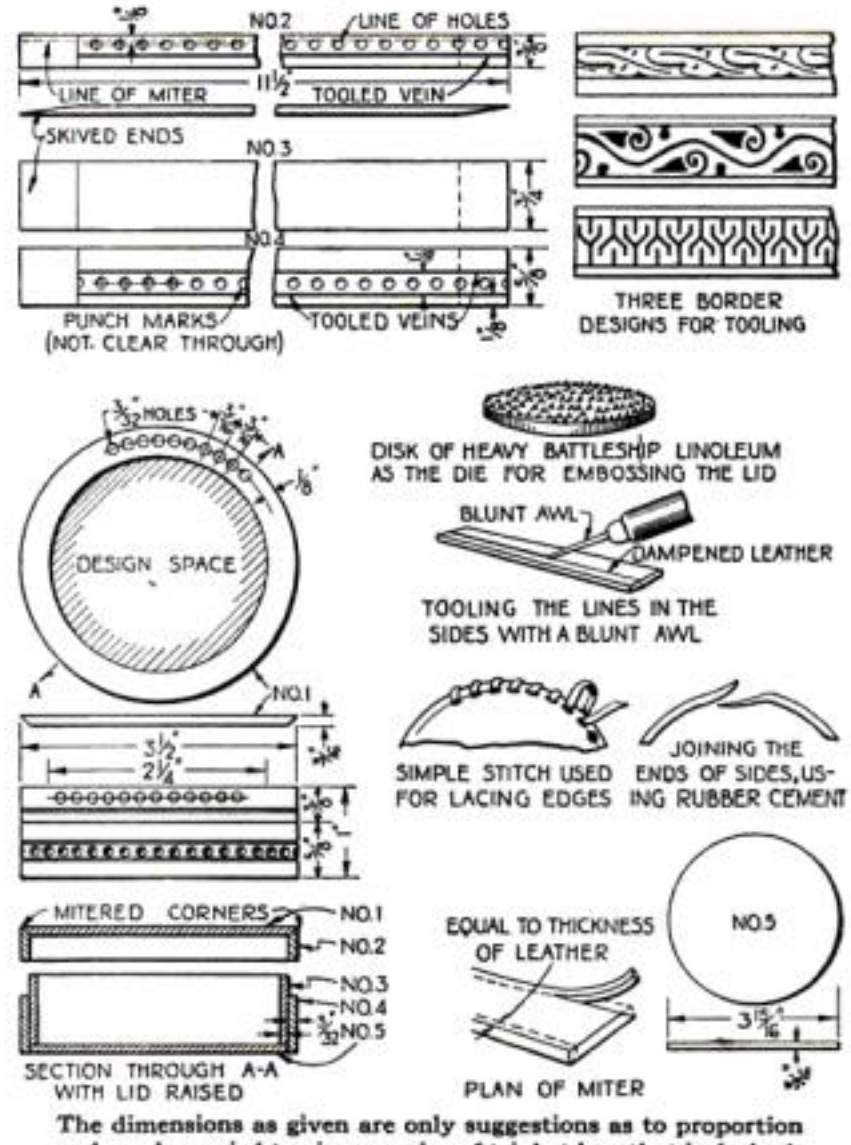
When all of the parts are cut and tooled, begin with the bottom, or No. 5, and fit and glue the sidepiece No. 4 to this. Either rubber or leather cement should be used, although ordinary glue will serve the purpose. These two parts should be allowed to dry thoroughly, after which the lining, or No. 3, is fitted and glued into place.

The holes for the lacing should be punched in the two parts of the lid before the miter is cut. This can be done with either an ordinary nail set or a regular leather punch. The laces, which should be about ⅛ in. wide, can be cut from any thin black leather, though kangaroo or wallaby skin is the best suited.

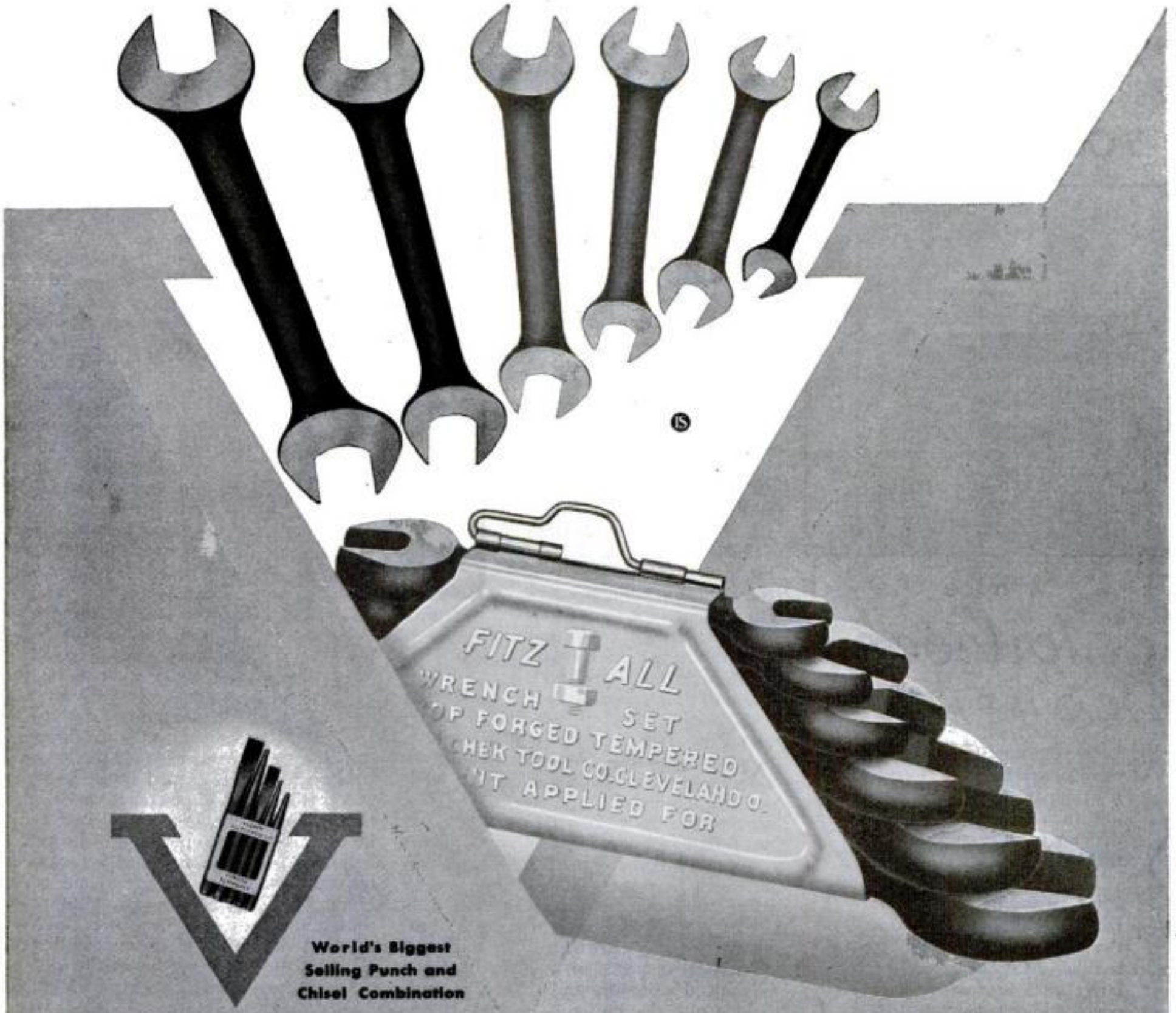
The two parts of the lid, which are mitered and laced together, should be fitted carefully to be sure that they match the main part of the box. The mitered edges will not be difficult for even the unskilled, if it is remembered that the miter is but a 45-degree angle and the diagonal of a square. By gaging a line along the inside the same distance in from the edge as the thickness of the leather, a true miter can be laid out.

The box may be lined inside, if desired, with a bit of felt, velvet, or thin lining leather. The outside should be finished with wax or shoe dressing.

If colors are desired in the finish, they may be applied as described in the preceding articles on leather work. (See P. S. M., Dec. '29, p. 102.)



The dimensions as given are only suggestions as to proportion and can be varied to give any size of trinket box that is desired.



World's Biggest Selling Punch and Chisel Combination

They started a TOOL REVOLUTION

A LITTLE over two years ago The Vlchek Tool Company first gave the mechanic and tool user a chance to profit by the vast Vlchek Research and manufacturing facilities . . . The two sets of tools shown above were the first to be introduced. They are familiar to thousands of readers of Popular Science. But, did you ever stop to think of the great volume of business that is necessary to enable us to give you a fine, high grade wrench, or chisel or other Vlchek Tool for the very low prices you pay for them?

Try a set. Test them. You will never again spend big money for such tools, for Vlchek volume production gives you fine alloy or carbon steel tools at far less than old time prices. If you would like to know of other tools made by The Vlchek Tool Company, watch the Vlchek advertisements in Popular Science. Almost all hardware dealers sell Vlchek Tools. The Vlchek Tool Company, Cleveland, Ohio.

VLCHEK

VLCHEK'S HIGH GRADE TOOLS COST LESS BECAUSE MADE IN VOLUME

Easily Constructed Wall Vase Made of Hammered Pewter

The long graceful lines of this wall vase make it an attractive ornament for any room.

PEWTER is an excellent metal for decorative metal work, being inexpensive, easy to handle, and attractive in appearance. Its advantages will be discovered in making a vase like that illustrated at the right, the construction of which is relatively simple and well within the capacity of a beginner in metal work.

The vase as shown was made by E. W. Manzer, who is manual arts supervisor at the Bronxville High School, Bronxville, N. Y. He entered the design in the elementary metal working division of a shop problem competition conducted by the Educational Department of POPULAR SCIENCE MONTHLY and was awarded the third prize.

A 2⅞ by 14⅜ in. piece of Britannia metal (pewter), a pair of tin snips, a file, some iron binding wire, a small piece of emery paper, fine steel wool, and a Bunsen burner are all that are needed for making the vase. If a Bunsen burner is not a part of your shop equipment, a gas stove can be used, but extreme care must be taken that the metal does not reach its melting point. No matter what means are used for the heating process, it is absolutely necessary that the pewter be placed on a sheet of metal so that the heat can be applied indirectly and kept in control.

Lay out the design on a piece of heavy paper and after brightening the metal, transfer the outline to the cleaned surface by means of a sharp pointed tool.

After the metal has been cut to the desired contour, file the edges and rub them with emery cloth to make them smooth. If desired, the surface can be enriched by the application of a few hammer marks.

The part to be used for the receptacle should be cut and formed next. Take care to make the edges square so that the seam with the back can be fitted tightly.

Fit the receptacle in place and wire it firmly to the backpiece with iron or copper binding wire. Be sure that the seam fits tightly and that there are no large cracks or spaces for the solder to fill.

The flux used in soldering pewter is made by mixing 1 oz. of glycerin and 5 or 6 drops of hydrochloric acid. Before applying it, see that the two edges which are to form the seam are clean.

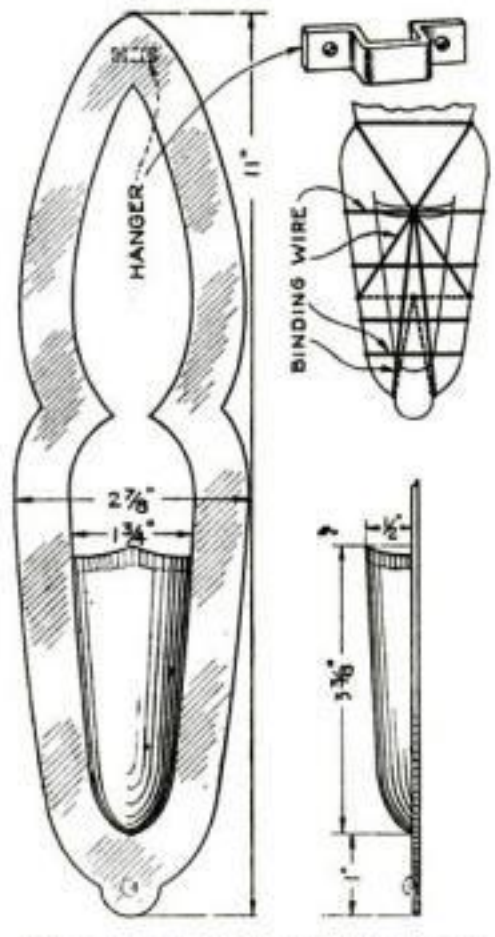
Small pieces of the pewter can be used as solder or 50-50 solder can be used. If wire solder is used, hammer one end of the solder flat and with a pair of tin shears snip off small pieces and place these pellets along the inside of the seam.

Place the whole vase on a piece of galvanized iron or sheet of steel and heat the pewter indirectly by applying the heat to the metal sheet. As pewter has a very low melting point, do not under any condition play the flame directly on the pewter. If a gas stove is used for the heating, be sure that it is turned down low. As the melting point of pewter is very nearly that of the solder, exceptional care must be exercised in the operation of heating.

Solder the little hanging attachment on the back in the same manner, using binding wire to hold it firmly in place during the heating. An easier and just as effective method of hanging is to drill a hole in the center portion of the top.

Clean the metal thoroughly with emery cloth and steel wool, and then coat the entire surface with a coating of thinned banana oil to prevent the forming of an oxide and the subsequent dulling of the polished surface.

If desired, this vase can be made of copper, brass, zinc, or common black iron, any one of which will lend itself admirably to the design.



The portion between the outside and inside lines in the front view may be hammered with a ball peen hammer.

THE ideal vise for home metal work is a swivel bench vise of the machinist's type having steel jaws from 2½ to 4 in. wide. If the vise has an anvil attached, it will serve for light hammering or riveting; otherwise an old flatiron, or a heavy piece of steel, such as a short section of a rail, will serve as an anvil.

The Non-Skid screw driver was inserted in the slot of one of the screws holding the license plate, and, with a firm turning pressure on the screw driver to bind the blade in the screw slot, the car was actually pulled, just as shown here!

The New NON-SKID TRADE MARK Screw Driver is such an AMAZING IMPROVEMENT that you will never buy another smooth blade

Pat. U. S. A. Dec. 3, 1929 No. 1738405

The RIBBED BLADE Prevents Slipping

THE new Non-Skid Screw Driver —the most *revolutionary improvement* ever made in a screw driver blade —is so much *better* that you'll wonder why it wasn't thought of before!

Take a "chewed-up" screw, securely sunk in hard wood, and just *try* to turn it with a smooth blade screw driver! It can't be done! Now insert a Bridgeport *Non-Skid*—see and feel how the *ribbed blade grips*. No pushing, no straining—you only *turn* the Non-Skid.

The Non-Skid *holds* like a gear in mesh. *Grips* a screw like a non-skid tire grips the road. Drives screws so much *easier* that you'll never want to *see* another smooth blade. Turns screws at almost *any angle*. Turns *battered* and *rusted* screws as though they were new. Turns *greasy* screws which smooth blades merely "skate" off. Saves furniture and flesh—and a tremendous amount of time. *Lasts longer*, because it doesn't get chipped and worn from jumping and slipping.

And the beauty of it is you can *try* the Non-Skid *before* you buy! Dealers everywhere are displaying the new Non-Skid screw driver with a *demonstration block and screws*, so that you can see for *yourself* what a whale of a difference a *ribbed blade* makes! Ask your dealer to show you the new Bridgeport *Non-Skid* today! If he is not yet supplied, order direct: No. 1—4", 50c; 6", 60c. No. 2—4", 35c; 6", 45c. No. 3—4½", 45c; 6½", 55c.

With a firm turning pressure on the screw driver to bind the blade in the screw slot, the 6" x 8" x 6' timber was lifted just as shown.

3 STYLES *All Sizes*

No. 1

Blade runs clear through handle. "The finest screw driver I ever owned," say thousands of mechanics and carpenters.

No. 2

Blade, handle and ferrule are riveted securely together. The best screw driver in its price class.

No. 3

Shock-proof up to 10,000 volts. Designed especially for electrical and cabinet work. Slim blade with magnetized point.

THE BRIDGEPORT HDWE. MFG. CORP.
Bridgeport, Connecticut
The World's Largest Makers of Screw Drivers

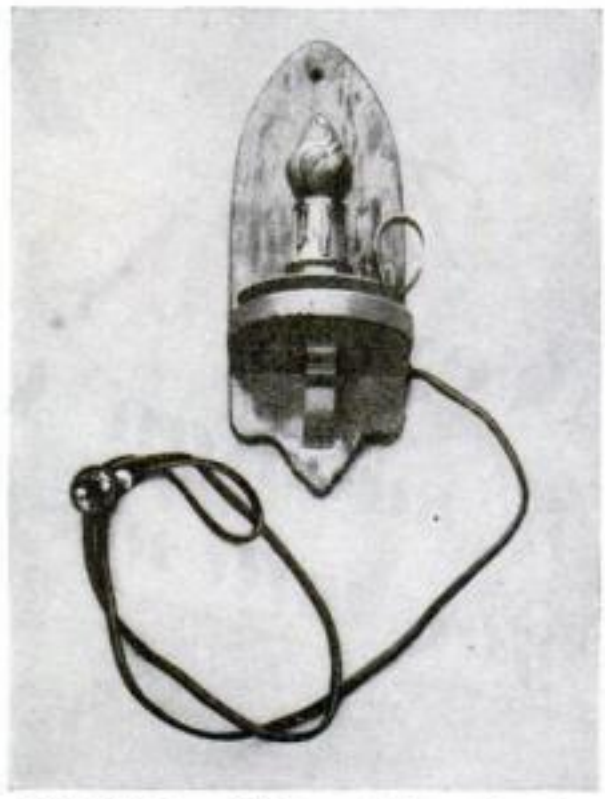
Bridgeport TRADE MARK

THE CHOICE *of* MEN WHO KNOW TOOLS

Making a Candle Side Light

By

DICK HUTCHINSON



This Colonial wall light can be hung from the picture molding or attached with a screw or nail.

ASIDE from its decorative value, the lighting fixture illustrated is both practical and easy to build.

The bracket, or shelf, is made of ¾-in. white pine, finished in gold bronze, and gone over carefully with a blowtorch or similar flame to scorch it and produce an antique appearance.

After drilling and cutting holes for the electric cord, the pieces should be assembled by first gluing and then nailing them together. Drive the nails from the back so that they will not show on the finished piece. A hole should be drilled near the top to take the hanging cord or nail.

After the piece is bronzed and burned, it should be lacquered with a coat of banana oil applied with a brush.

The sheet brass used for the candlestick is No. 16 gage, and the piece of 1½-in. brass tubing used for the candle base has a wall of about the same thickness as the brass. The tubing is 1¼ in. long.

With the tin shears, cut a disk of the sheet brass 4 in. in diameter, and smooth up the ragged edges with a file.

For hammering this piece into a saucer shape, some sort of a smooth surface steel block, or anvil, and a ball peen hammer will be required.

Hold the brass disk firmly in the left hand, placing it on the steel block so that the portion farthest from you is slightly raised, and hammer with the ball end of the hammer, hitting about an inch in from the edge. Drive each blow toward the outer edge of the disk, moving around the piece and at the same time working out to the edge. Be careful, however, not to strike the extreme edge or it will spoil the appearance. Now begin inside the hammered section, and work around to the center, this time driving toward the center.

Next, drill a ⅜-in. hole in the center, two holes for attaching the handle, and two more for attaching the saucer to the shelf.

Place a piece of iron pipe in the vise, and slide over it the brass tubing for the candle holder. Raise the tubing up until it makes a 45-degree angle with the iron pipe, and hammer a flange on one end with the ball end of the hammer. Remove from the pipe and place the tube on one end of the steel block and finish the flange from the inside.

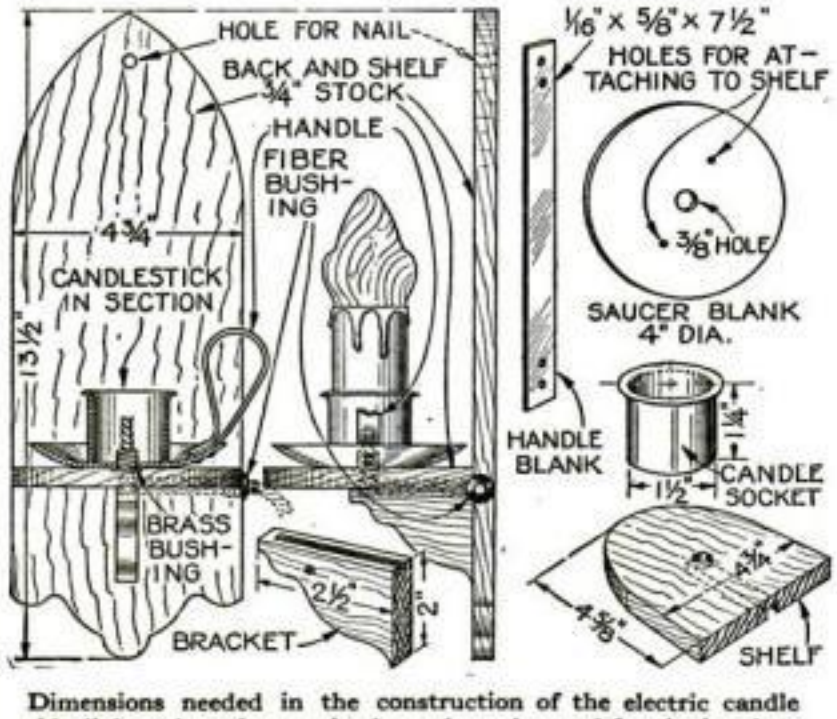
The handle, ⅝ in. wide and 7½ in. long, is hammered on one side and then bent to shape (see drawing). Holes are drilled to correspond with the handle holes in the saucer, and the handle is riveted in place with No. 14 brass escutcheon pins.

With a blowtorch or other source of heat, bring all pieces to such a heat that they darken slightly; this gives them an antique appearance. Then solder the cup in place in the center of the saucer.

Insert a fiber fixture bushing into the hole in the wood bracket and run the end of the drop cord in through this and up through the hole in the center of the shelf. Wire it to the candle socket.

Attach the completed candlestick to the bracket shelf with wood screws, and the piece is complete.

A cord may be attached and the fixture may be hung from the picture molding, if preferred, rather than nailed to the wall.



Dimensions needed in the construction of the electric candle side light. Any close-grained wood can be used for the bracket.

MANY old screw drivers give trouble because they constantly slip. This is caused by the fact that the point has been ground or filed at too sharp an angle.

» AN AMAZING IMPROVEMENT IN RECEPTION FROM YOUR PRESENT RADIO RECEIVER « WITH NEW EVEREADY RAYTHEON 4-PILLAR TUBES

THE inevitable jolts and jars of shipment and handling can't budge the elements in an Eveready Raytheon Tube by as much as a thousandth of an inch. Their accurate spacing, which assures maximum performance, is immune to these common hazards.

The 4-*Pillar construction*, which gives Eveready Raytheon Tubes their remarkable strength, is patented and exclusive. With no other tube can you get all its advantages. If you examine the illustration at the bottom of this page, you will see the superiority of this construction.

This is especially important in receiving tubes which have large and heavy elements—tubes such as the 224 screen grid, the 280 rectifier, and power tubes used for push-pull audio amplification, requiring perfectly uniform characteristics.

People everywhere, using Eveready Raytheons in their receivers, report increased distance, more power, better tone and quicker action. To get the most from *your* receiver, put a new Eveready Raytheon in each socket. Your dealer has them in all types—including the famous B-H tube for "B" power units.

NATIONAL CARBON CO., Inc.
General Offices: New York, N. Y.
Branches: Chicago Kansas City
New York San Francisco
Unit of Union Carbide UCC *and Carbon Corporation*

4-PILLAR TUBES

Showing the exclusive, patented Eveready Raytheon 4-*Pillar construction*. Notice the sturdy four-cornered glass stem, the four rigid supports, and the stiff mica sheet bracing the top.

EVEREADY RAYTHEON

Trade-marks

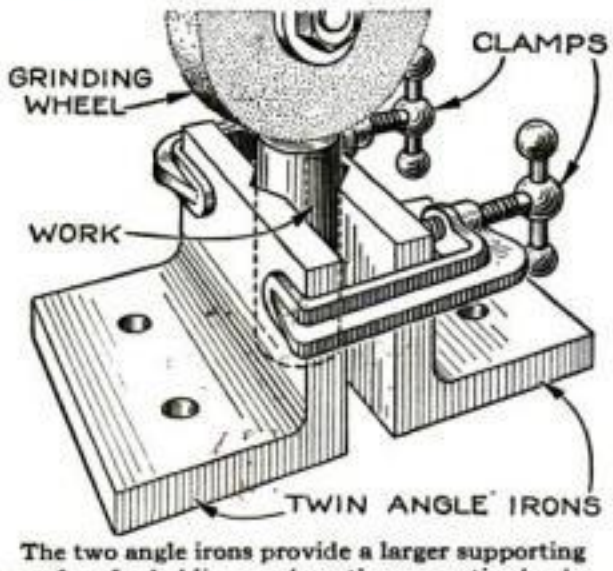
4-PILLAR SCREEN GRID

Eveready Raytheon Screen Grid Tube, ER 224. The weight of the four large elements in this type of tube makes the exclusive Eveready Raytheon 4-*Pillar construction* vitally important.

Two Angle Irons Used to Hold Work to Be Ground

BY USING a set of angle irons having 45-degree grooves cut in them as shown in the illustration, the grinding of round objects will become a simple matter.

When high pieces are to be ground the angles supply a double surface for the pull of the magnetic chuck, and the danger of having the work come loose and break the wheel is eliminated.—F. J. WILHELM.

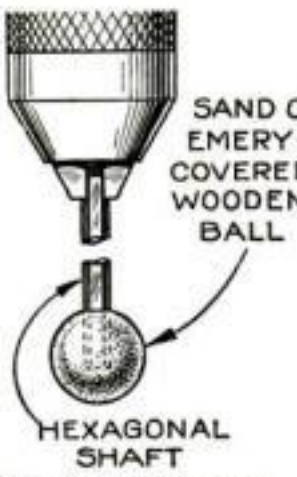


The two angle irons provide a larger supporting surface for holding work on the magnetic chuck.

Handy Sander for Use on Small Curved Surfaces

CURVED and small concave surfaces can be readily sanded by using the small ball sander illustrated.

Machine a section of hexagonal stock to the size desired and affix to its end a small wooden ball. This ball is then dipped in glue and fine sand or emery dust and allowed to dry.



The hexagonal shaft fits in a drill chuck.

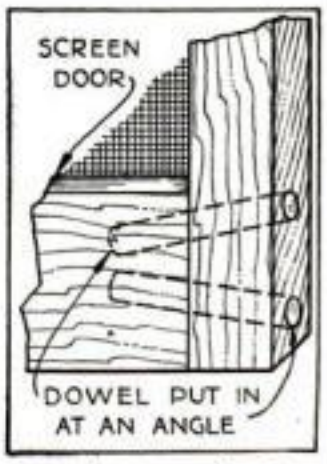
The hexagonal shape of the shaft will prevent the ball from turning and will also fit snugly in a three-jaw portable electric drill chuck.

In use, the sander is mounted in an electric portable drill and is operated in much the same manner as a router bit.

While glue forms an excellent bond, the writer has had much success with water glass.—ADDISON DU BOIS.

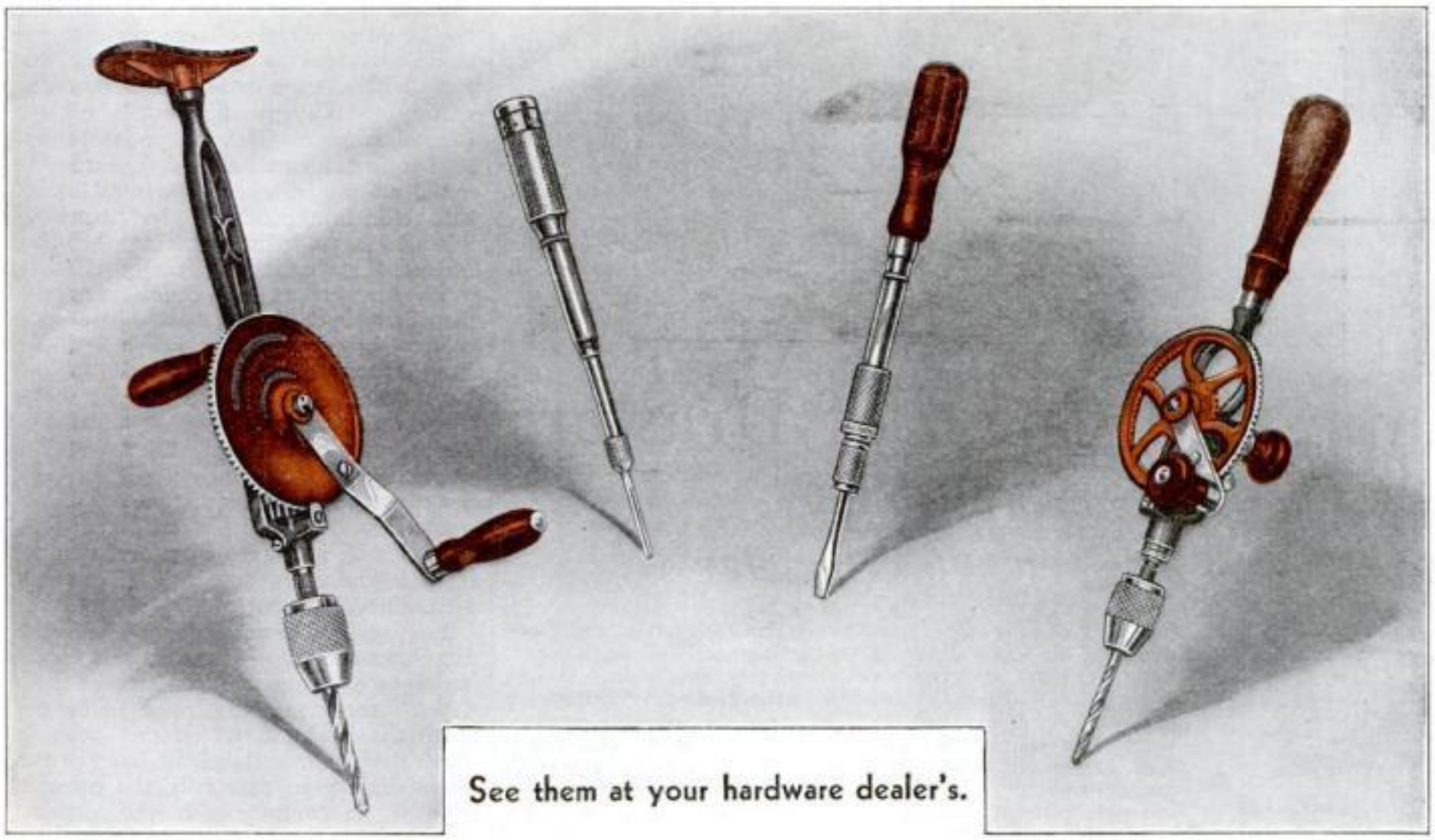
Simple Joint for Windows

WINDOWS and screen doors can be assembled strongly by the butt joint and dowel method illustrated. Making the joints in this way saves considerable time, especially if the mortise and tenon joints must be made by hand.—F. J. PEASE.



Dowels are put in the butt joint at an angle.

Mr. Punch says, "These four Goodell-Pratt tools are favorites with men who appreciate fine tool craftsmanship."



See them at your hardware dealer's.

No. 5½ Hand Drill The most practical hand drill made for all-around use. Capacity to ⅜". Two speeds — easily changed with Shifter Knob. No holding back when drilling through. Simply shift to "Slow" speed. Polished Rosewood Handle. Spindle runs in ball bearings. Hollow handle for holding drills. Frame is strong, malleable iron. A comfortable drill to use. A good looking tool that you'll be proud to own.

No. 6 Breast Drill How many times have you wished for a real breast drill? One that you could put some "heft" behind on a real tough job. The price at which you can buy this drill is very reasonable. It will take drills up to half-inch. There are two speeds, changed by turning the Shifter Knob marked "Fast" or "Slow." The shifting mechanism is very strong and reliable.

Mr. Punch This automatic drill carries eight sizes of drill points — 1/16" to 11/64". Pick out the size you want, insert it in Mr. Punch's steel jaws, place point where you want the hole. You push. He twists. In goes the point and — presto, you have a clean smooth hole in any wood. Also can be used in plaster. Just the tool for household repair work. Remember the name and look for Mr. Punch on the green-covered box.

No. 811A Automatic Screw Driver To drive screws with lightning speed or to draw them out just as fast, you cannot find a better tool than the No. 811A Automatic Screw Driver. The shifter knob controls the action right or left and when at "neutral" the tool can be used as a plain screw driver. Each screw driver is provided with three tool steel blades, hardened, tempered, and polished. A real handy tool for the home workshop.

GOODELL-PRATT COMPANY, GREENFIELD, MASS. Ⓑ

Calipers, Dividers, Micrometers, Hack Saw Blades, Feeler Gauges, Depth Gauges, Electric Drills, Lathes, Levels, Squares, Straight Edges.

GOODELL-PRATT
1500 GOOD TOOLS

Wrenches, Pliers, Tool Sets, Repair Kits, Valve Lifters, Carbon Scrapers, Glass Cutters, Bit Braces, Mitre Boxes, Nail Sets, Punches.

Ⓑ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Cape Cod Chest of Drawers

A handsome and useful piece that you can make yourself

LePage's Third Home Work Shop Book, only 10 cents, Shows How to Make These 20 Projects

Cape Cod Chest of Drawers, Alexandria Nest of Tables, Old Salem Ship's Cupboard, Plymouth Built-In China Closet, Lady Washington Sewing Cabinet, Set-Back Book Shelves, Modernistic Desk, Modernistic Table, Modernistic Folding Screen, Modernistic Fire Screen, Chess and Checkers Table, Smoking Table, Caned Side Chair, China or Book Cabinet, Book Trough and Magazine Stand, Magazine Carrier, Vanity Case, Book Stand, Fernery Stand and Folding Sewing Screen.

Complete step-by-step directions and dimension drawings of all the parts are given on page 3 of LePage's Third Home Work Shop Book so clearly and simply that any man handy with tools can easily make this handsome and useful piece at little cost—or any of the other attractive, useful projects found in LePage's Third Home Work Shop Book or in LePage's Job Plans.

Expert Instruction

You have expert instruction to guide you. The designs, dimension drawings, photographs, step-by-step directions and the actual furniture itself were made by William W. Klenke, Instructor in Woodworking, Central Commercial and Manual Training High School, Newark, New Jersey. His experience as an expert gives assurance that each project and the directions for making it are thoroughly practical. Look over the contents of LePage's book and the Job Plans available as shown in the column at the left. The price of the book is 10 cents. The Job Plans are 10 cents each and are for projects requiring more elaborate instructions than those shown in the Book. In all cases the instruction consists of printed step-by-step directions, dimension drawings of full-size patterns, and a photograph of the finished article.

Send 10 cents for Le Page's Third Home Work Shop Book

Simply use the coupon below, sending it to us with 10 cents in coin or stamps, and we will at once send you a copy of this latest LePage's Book, postage paid.

Job Plans 10 cents Each . . . Order by Number as Indicated in Coupon

16 Sheraton Writing Desk
17 Sheraton Desk Chair
18 Colonial Hanging Book Shelves
19 Smoking and Reading Cabinet
20 Colonial Mirror
21 Tea Wagon
22 Telephone Cabinet
23 Stool for Telephone Cabinet
24 Manual Training Work Bench
25 Home Worker's Tool Cabinet
26 Spanish Galleon
27 Vanity Table

Mail This Coupon

LE PAGE'S GLUE

HANDIEST TOOL IN YOUR WORK SHOP

LEPAGE'S CRAFT LEAGUE
720 Essex Ave., Gloucester, Mass.

Gentlemen: Enclosed please find 10 cents (coin or stamps) in payment for LePage's New Third Home Work Shop Book. Please send a copy of this book to:

Name.....

Street.....

City.....*State*.....

Please also send the following Job Plans..... (indicate by number those you want. See columns above), for each of which I enclose an additional 10 cents.

Putting an Edge on a Pocketknife

AN EXAMINATION of any group of pocketknives probably would reveal as many different kinds of edges as there are knives.

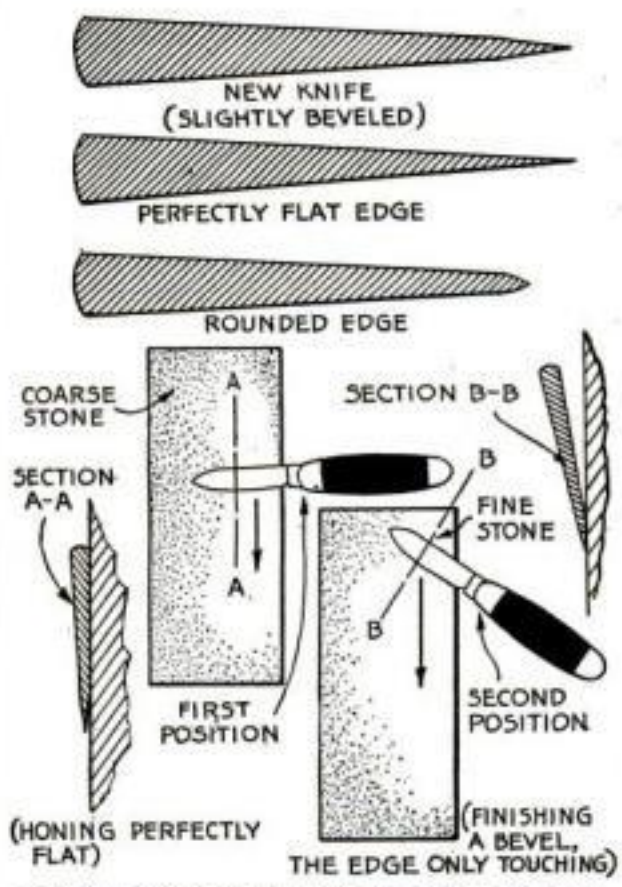
Most of us sharpen knives by holding the blade at a rather large angle to the stone and moving the blade back and forth with a more or less careless rolling motion that eventually rounds off the edge and gives it a shape somewhat similar to the small end of a pear. The impulse to avoid honing the full width of the blade is a good one, but a serious mistake is made in rounding the edge instead of giving it a distinct bevel.

To sharpen a pocketknife correctly, first hone both sides of the blade on a coarse carborundum or other artificial stone. Place the stone lengthwise to you, lay the blade of the knife straight across the stone, and hold it firmly with the finger tips of both hands. Keep the blade flat and work it down until you have almost reached the cutting edge. Then stroke it in the same way on a fine stone to polish it, still keeping it flat. If the blade is uniformly honed it is then ready for the beveling process.

In applying the final edge to the blade, use either a hard or soft Arkansas finishing stone or a fine artificial stone.

With the stone lengthwise as before, place the blade in the second position illustrated below. Raise the back of the blade slightly so that only the extreme edge is in contact with the surface. Slowly draw the blade toward you. Be careful to keep the angle and pressure uniform, and make each stroke cut evenly and smoothly from the heel or tang to the point. Turn the blade at the end of each stroke and sharpen against the edge at all times. A few strokes are enough.

To remove any burr, hone the blade very lightly, first on one side and then on the other.—HENRY GEORGE.



Right and wrong types of edges, and two steps in obtaining a keen, lasting bevel on a knife.

Why I want a CORONA typewriter

This contest *is open to all. Write a letter of not more than 200 words, explaining why you want a Corona typewriter. The best letter will win a prize of $1,000. Second prize is $250. Ten prizes of $25 each. Letters will be judged according to the value and soundness of reasons presented for wanting Corona, rather than according to literary merit. Letters may be typed or hand-written.*

Contest closes May 1st. Winners will be announced as quickly as possible.

$1,500. CONTEST

First PRIZE

$1,000.

MORE than one million users have learned that Corona is a marvelously efficient typewriter—smooth and responsive in action, sturdily built for a lifetime of service and an amazing aid to living for every member of the family.

One unique mechanical superiority of Corona is its one-piece, solid aluminum die-cast frame of tremendous strength and rigidity. With this powerful frame Corona does not have to be kept screwed to a wooden base—it stands on its own feet, takes up less room on a desk and is more attractive.

Another advantage—the sheet as typed is held at exactly the right angle for easy reading. Anyone who has used other machines will appreciate this feature.

Corona is the product of twenty years' effort of skilled typewriter engineers to create a perfect small typewriter for personal use. It has everything and does everything. It is small in the sense that a fine watch is small. Working parts are manufactured with exact precision—in some cases to one thousandth of an inch.

Coronas are finished in Scarlet, Green, Blue, and Maroon, with attractive panelling of modern design. Also black and gold, and black with art panels. Seven color combinations to select from.

There is only one way to know Corona. Try it in your home. It is easy to Coronatype. In a remarkably short time you can Coronatype faster than you can write.

Insist on a Corona demonstration. Any Corona dealer will be glad to deliver Corona on trial.

Time-Payment Plan. Fit our convenient time-payment plan into your family budget. You can own Corona without even feeling the cost. A few dollars down brings it to you. Then you pay a little every month.

Corona with standard keyboard costs $60. Corona Special with three-row keyboard costs $39.50. An attractive carrying case is furnished with either model. An allowance will be made on your old typewriter.

Don't forget the "Why I Want Corona" contest. Sit down now and catalog all the ways in which Corona will be useful to you, the help it can be in school work, club and committee work, business, writing, home management, correspondence. Ask your local Corona dealer for further information. Remember, the best reasons for wanting Corona win $1,000.

Note to dealers: Write for our agency proposition.

L C SMITH & CORONA TYPEWRITERS INC

1813 New York Life Building, 51 Madison Avenue, New York City

Blueprints for Your Home Workshop

TO ASSIST you in your home workshop, POPULAR SCIENCE MONTHLY offers large blueprints containing working drawings of a number of well-tested projects. Each subject can be obtained for 25 cents with the exception of certain designs that require two or three sheets of blueprints and are accordingly 50 or 75 cents as noted below. The blueprints are each 15 by 22 in.

Popular Science Monthly,
381 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....
.....dollars.....cents.

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69. Lindbergh's Monoplane (3-ft. flying)
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87. 30-in. Seaplane
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104. Tractor (record flight 6,024 ft.)

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2. Smoking Cabinet
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13. Tea Wagon
17. Cedar Chest
18. Telephone Table and Stool
19. Grandfather Clock
20. Flat Top Desk
21. Colonial Desk
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Price 25 cents each except where otherwise noted

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Buy Quality Paint Brushes

A Good Brush, Well Cared for, Will Give Amazingly Better Results

READERS of Popular Science who are expert painters will tell you that no one should begin a paint job without first making sure that his brushes are absolutely clean and in first class condition. Experience has taught the professional painter that a good, clean brush is just as necessary as is good paint to get a smooth, beautiful, long-lasting paint job. Don't make the fatal mistake of attempting to paint with a "cheap" brush or an old brush that has never been properly cleaned. You will get amazingly better results if you buy quality paint brushes and take care of them.

In selecting a quality tool, the brush buyer should give careful attention to the kind, length, quality and fullness of the bristle stock. It is very easy to become confused by two brushes which may look alike, but differ in cost as much as 75c to $1. However, a close comparison of two such brushes shows that the quality brush has a better stock of bristles which are clean, straight, springy, and full of "oily life". The safest way to get quality is to buy a brush made by a well-known and responsible brush company, such as a Wooster Foss-Set Brush.

Equal in importance to the quality of the bristles is the kind of setting used in a brush. Many a man has lost his temper because an apparently good brush shed bristles, swelled, or came apart just when it was nicely "broken in."

Fig. 1. In order to protect brush buyers against imitation, all genuine Wooster Brushes are stamped with the Foss-Set trade mark on the handle, or metal ferrule.

Foss-Set, used only in Wooster Brushes, is a perfect bristle holding compound because it not only holds the bristles in a vise-like grip, but is unaffected by the powerful solvents found in modern painting materials. A Wooster Foss-Set Brush can be used in anything — the bristles can't come out!

How to Take Care of Your Brushes

This is the all-important thing if you are going to get good painting results. Always remember a good brush is a *fine tool* and must be kept even more carefully than you keep your saws or drills. Be sure to clean brush thoroughly immediately after using. In a few hours the paint, varnish or other material begins to gum up at the base of the bristles and is much harder to remove. Paint brushes should be washed clean in benzene, kerosene, gasoline or turpentine. Varnish brushes should be washed in turpentine, although a first wash of benzene is satisfactory if the final rinse is in turpentine. Shellac brushes should be washed in denatured alcohol. Lacquer brushes should be washed in lacquer thinner, or first in alcohol and then in in lacquer thinner. Kalsomine and fresco brushes are washed in two parts of water and one part of vinegar. They should be hung up by the handles to dry, not laid out flat as paint brushes usually are.

When Not in Use

A Wooster brush will last you a long time if kept the RIGHT WAY after cleaning. See Fig. 2 for liquid storing. For dry storage, after cleaning *thoroughly*, wrap bristles in heavy paper, held tightly by rubber band or string.

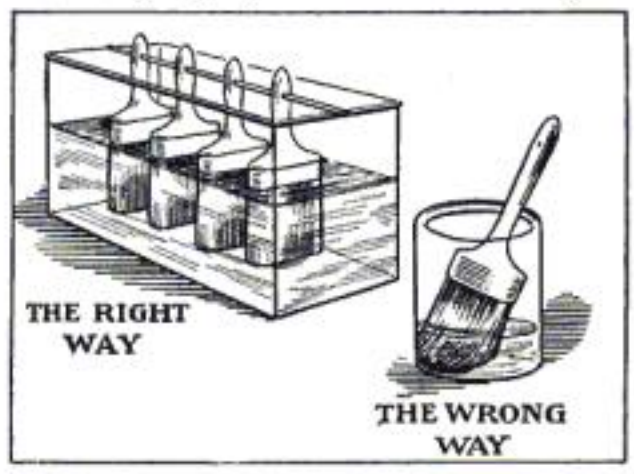


Fig. 2. Hang brushes in a can on a line or rod so that bristles *do not touch bottom*. Keep paint brushes in linseed oil mixed with a little turpentine—varnish brushes in brushkeeper varnish.

Get the Right Brush

There is no economy in using a "cheap" brush or one that is too small. Paint or hardware dealers who sell Wooster Brushes can give you expert advice in selecting the right brush for every paint job. This folder will help you also. See Fig. 3.

Fig. 3. This folder gives helpful hints on the selection, use and care of good brushes. It is sent with every Wooster Test Brush (described in next column) or it will be supplied *free* on request to The Wooster Brush Co., Wooster, Ohio.

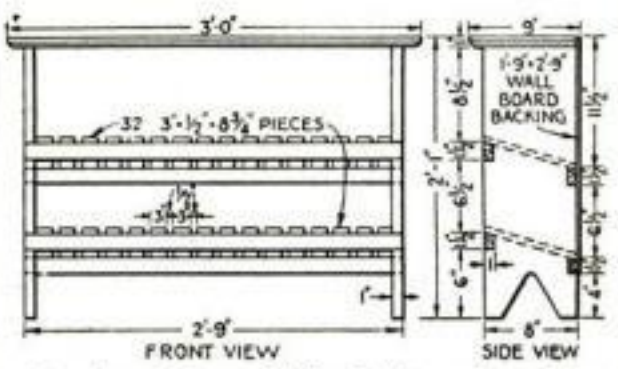
Handy Rack Provides Vegetable Storage

The rack also provides an extra shelf for holding canned goods, bread boxes, jars, or milk bottles.

VEGETABLE racks for the pantry and kitchen take up little room and allow a quick choice of any of their contents.

The rack illustrated is large enough for the average family and can be made from scrap pieces of lumber. The writer made the thirty-two ½ by 3 by 8¾ in. slats from lumber salvaged from lettuce crates. The piece of veneer on the back of the rack was taken from an old dry goods box.

The finish is a question of personal choice. However, if the rack is given two coats of flat white and then finished with two coats of white enamel it can be easily cleaned and will harmonize with any color scheme that already exists in the kitchen.—ARTHUR H. SCRIVEN.



If a piece of plywood is handy, it can be used to advantage in place of wall board for the back.

How to Remove White Spots from Mahogany Tables

WHITE spots such as those caused by hot dishes on a mahogany table top sometimes can be removed simply by rubbing them lightly with powdered pumice stone. The idea is to remove the discoloration but not cut right through the varnish, shellac, or lacquer.

Should the spots still show, wipe them with benzine or gasoline to remove every trace of grease and apply a thin coat of shellac—two parts of ordinary shellac and one part of denatured alcohol—to the spots only.

Use a small soft brush for this, or, better still, a spray, and work quickly. Do not go over any part already touched. Let the shellac dry for an hour. If the spots have not disappeared, apply a second coat, allow it to dry, and then rub it as before.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

CARBON-ZINC cells that will give two hours of steady service at a voltage of between 1.2 and 1.5 and that will recuperate to full voltage in 24 hours can be made easily in the home laboratory for experimental work. They will light small flashlight bulbs and can be used for many electrical experiments.

Each cell consists of a wide glass beaker inside of which is placed a cylindrical cup of plaster of Paris. Outside of the cup a cylindrical strip of zinc is placed and in the cup is placed a carbon rod which may be taken from an old dry cell. A concentrated solution of ammonium

The molds for the plaster cups can be made from heavy paper in the manner illustrated.

chloride in water is placed in the outer glass and the cup is filled with a solution of cupric chloride and ammonia. The latter solution is made by adding ammonia water to the cupric chloride solution until the precipitate first formed is redissolved.

Another experimental cell giving from 4 to 6 hours continuous service at a voltage of from 1.5 to 2 also consists of a carbon rod, a plaster of Paris cup, and a strip of zinc. The zinc is surrounded by water containing one or two drops of sulphuric acid. The carbon rod is placed in a solution of sodium or potassium bichromate in water to which ¼ to ⅛ its volume of sulphuric acid has been added. This cell must be cleaned after use and freshly prepared chemicals used each time the cell is to be operated.

Always remember, when using strong acids, to pour the acid slowly into the water and stir; never add water to acid.

GLUTIN, which is prepared from flour, is one of the most adhesive substances known.

To prepare, place a handful of flour in a piece of muslin and wash it with water, kneading the flour until the wash water is no longer milky from the starch. Glutin remains and should be placed on a glass dish to dry.

To use, take a small flake, add a drop or two of water, and allow it to stand 5 or 10 minutes. Knead it until it is soft and then apply it to the joint.

This glue is adapted to any use, especially for leather work.—H. BADE.

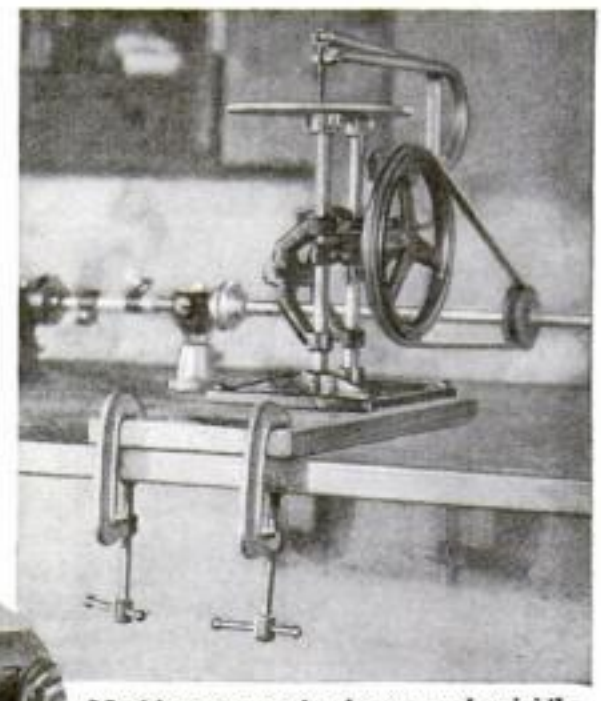
Seven Motorized Shop Aids

By

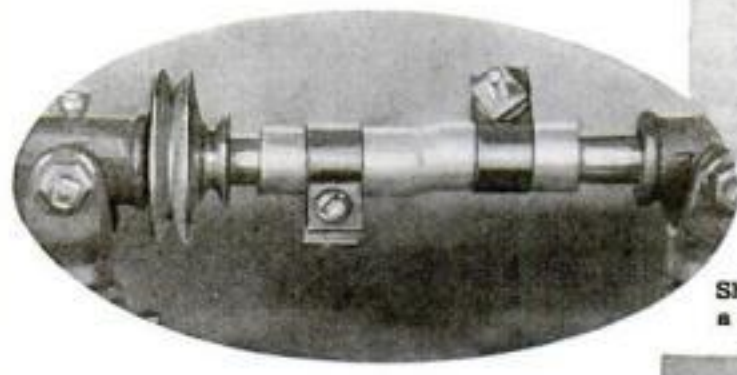
RAYMOND B. WAILES

PROBLEMS in planning and arranging a motorized workshop vary with the space available, the machines to be used, and the type of work to be done, but there are a few kinks that can well be incorporated in any shop, large or small.

Semipermanent machines mounted on wooden bases can be effectively and quickly held fast for connection to the line shaft by the use of C-clamps. By varying the length of these wooden bases, one length of drive belt can be used on any of the machines.



Machines on wooden bases can be rigidly attached to the bench with C-clamps.



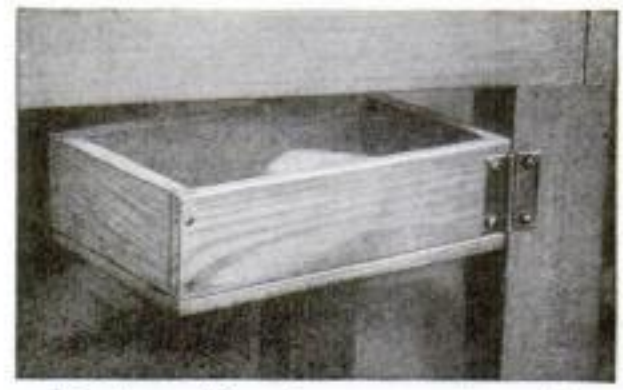
Shafts can be effectively coupled by means of a piece of hose clamped on as at the left.

The problem of connecting two shafts becomes an easy one if rubber hose and metal hose clamps are used in the manner illustrated in the illustration above. This method has an added advantage of working even if the shafts are a trifle out of alignment. The tearing limit of most high-grade rubber tubing is very great and for this reason a large running load can be transmitted.

A lathe wrench will never be misplaced if it is fastened to a length of chain which is in turn attached to the underside of the lathe bench.

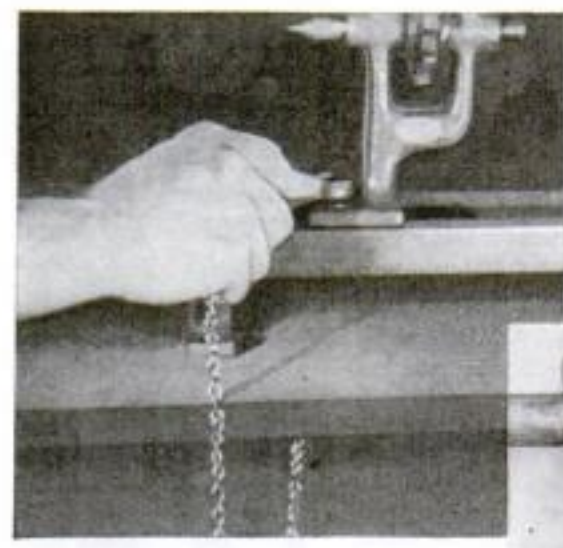
End play in shafts can be prevented by means of pulleys or collars, but BX cable box connectors serve well, and it is easy to screw them tightly to the shaft close up to the hanger. They have the added feature of low cost.

Many shops are limited as to the space that can be used for storing tools, buffing rouge, rag wheels, wire wheels, emery wheels, slip stones, pulleys, sanding disks, and many other auxiliary tools. A small box of simple construction bolted to a hinge, which is in turn mounted to one of the legs of the workshop table or bench, is handy for storing anything that is used frequently. The box can be moved out in an instant, and then turned back out of the way.



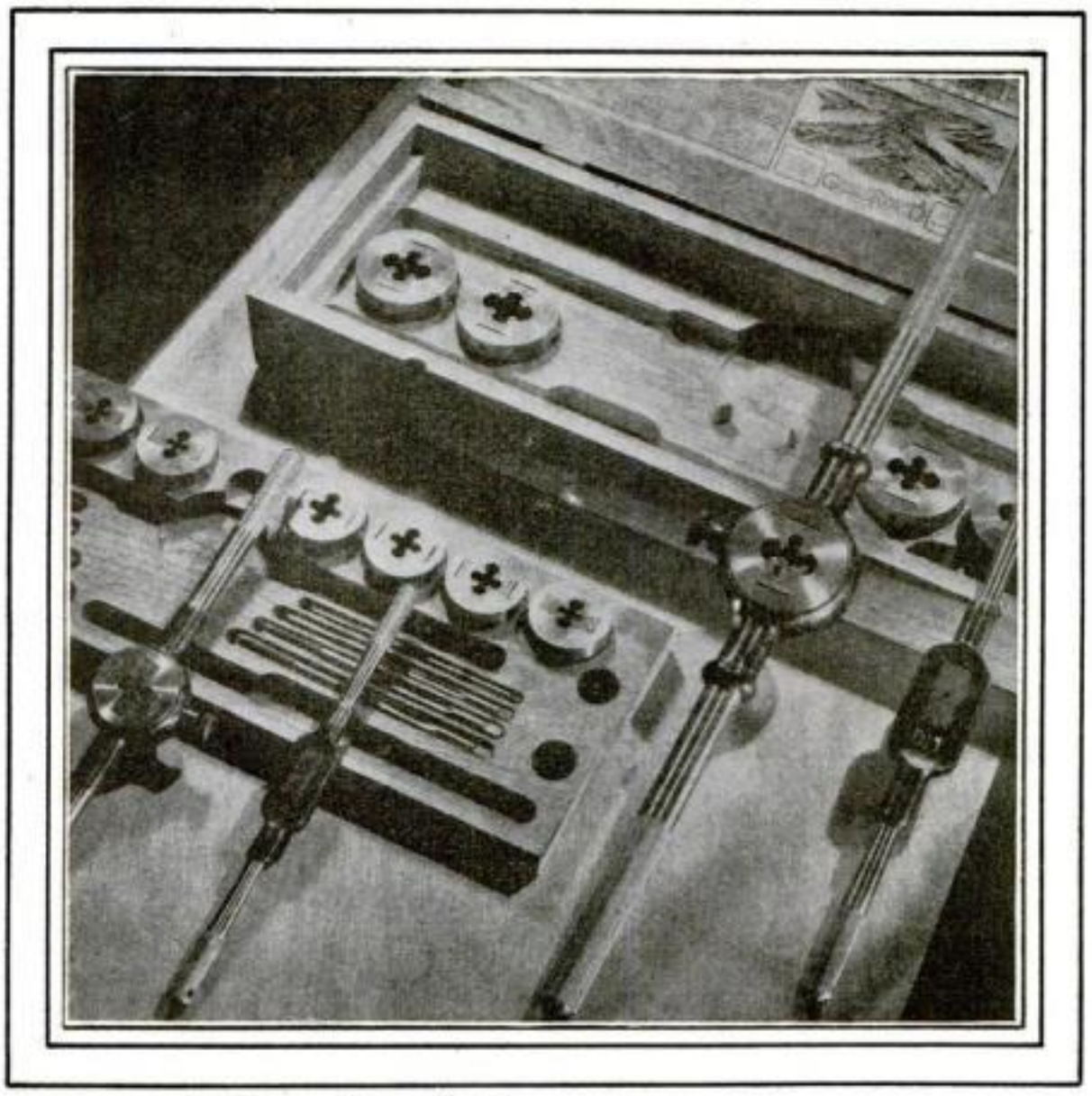
Handy swinging drawers supply ample space for accessories needed in a hurry.

Extra pulleys are always needed in the motorized shop and form an added item of expense. Wooden driving pulleys can be turned on a lathe, or if extra large ones are needed, they can be turned to shape on a buffing head supplied with an improvised tool rest placed in the proper position. The blanks or disks can be cut to shape on a jig saw and mounted on the buffing-head shaft. The groove can be cut with a rat-tail file. Wooden pulleys such as these, if mounted on the buffing head, are very useful in altering the speed of line shafts and other devices. The main driv-



A length of chain will keep the lathe wrench where it ought to be.

Shaft end play can be prevented by the use of a BX cable box connector.



This is a *Greenfield* "*Little Giant*" Screw Plate Set No. 311 . . . the world's standard for precision and stamina. This thread cutting set is a joy to the man who has tried to handle threading with ordinary tools.

With this world-famous set *even amateurs can do a precision job!*

Every *he* man loves fine tools. The greater his skill, the greater is his admiration for them. And it's amazing what excellent work even the rankest amateur can turn out with really fine tools.

Take thread cutting, for example. The "*Little Giant*" Screw Plate Set shown above is used by highly skilled mechanics in every civilized country in the world.

"*Little Giant*" Screw Plates were the choice of the United States Navy's Round-the-World Flyers several years ago, and of Commander Byrd's Antarctic Expedition. Men who *know* and who must have reliable threading tools, always pick "*Little Giants.*"

Put this admirable tool in the hands of an amateur . . . the man who just uses threading tools occasionally in tinkering around the house, or the garage, or on the farm . . . and he can't help doing a better job. He finds his threading jobs are turned out easily and with a precision that gives real satisfaction.

Good tools make all the difference in the world. Those who use them in quantity know this well. That's why "*Little Giant*" Screw Plates and other famous *Greenfield* small tools are standard equipment in large automobile factories . . . in big railroad shops . . . in aircraft plants and in maintenance shops at leading airports — the world over.

If you're a skilled mechanic you probably already use *Greenfield* small tools. If you do just an occasional job requiring threading or other small tools, you must get acquainted with *Greenfield* quality. You'll be proud of the work you can do with fine tools like these.

Ask your dealer—or write today for illustrated folder with complete information and prices on "*Little Giant*" Screw Plate Sets . . . or other *Greenfield* small tools which interest you.

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2 DIES
3 SCREW PLATES
4 TWIST DRILLS
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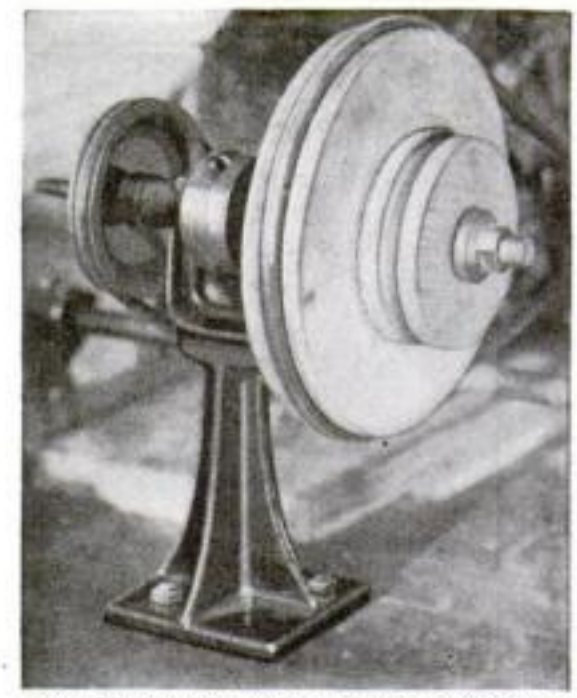


Sets of homemade wooden pulleys attached to the polishing head serve as speed reducers.

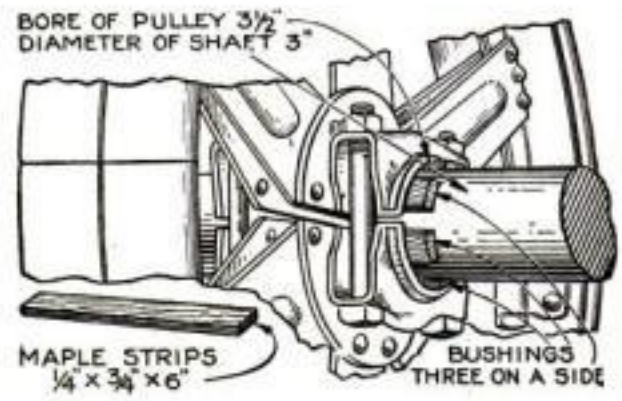
ing belt can always be tightened easily if the motor is mounted on a slotted wooden base. A screw passing through a slot in the base and then into the table top permits the motor to be brought forward or moved backward to loosen or tighten the belt. Small wooden guide rails on each side of the wooden base will prevent any side motion of the motor.

Wood Used as Emergency Bushing for Pulley

IN AN emergency it is sometimes necessary to fit a split pulley to a shaft of much smaller diameter than the bore for which the pulley was intended.

This can be accomplished by cutting six pieces of hard maple to size and inserting them as in the case illustrated, where a 3½ in. bore pulley was fitted on a 3-in. shaft. The pieces in this instance measured ¼ by ¾ by 6 in.

When the maple pieces are set between the pulley and the shaft as indicated,



Six maple strips of the correct size are inserted between the pulleys and the shaft.

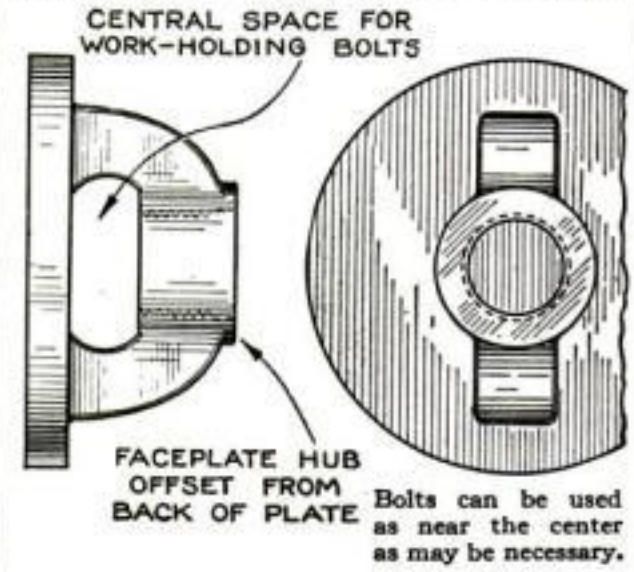
three on a side, the bolts on the pulley are drawn up tight.

In the instance where this makeshift was used by the writer, the pulley worked under a heavy load for several hours and did not show the slightest signs of slipping.—H. L. WHEELER.

TO ADJUST a bell for use in connection with a transformer, the gap at the breaker points should be made smaller than it was when used on batteries, because a more rapid make and break is necessary in order to keep ahead of the alternations of the current.

Faceplate of Novel Design Aids in Lathe Work

ORDINARY faceplates, because of their large hubs and center holes, often present difficulties where small pieces of work are to be attached to them with the aid of bolts. This is especially true if the



Bolts can be used as near the center as may be necessary.

bolts which hold the work are to be placed near the center portion.

To meet this difficulty, the faceplate illustrated was designed. It has no center hole, and its hub is constructed so as to allow easy access to its central portion, thus facilitating the attachment of bolts and clamps.

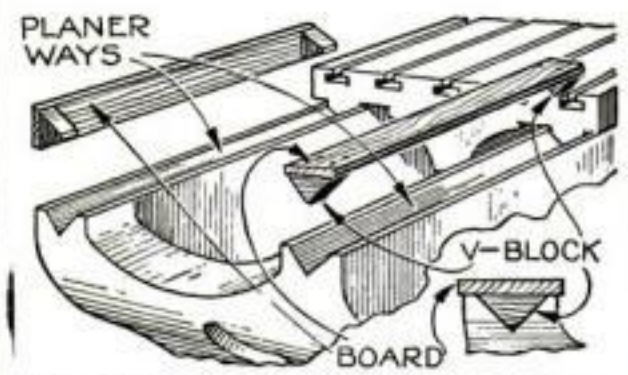
The pattern used in molding such a faceplate can be simplified if it is split on a center line through the curved supports of the hub.—S. A. ASQUITH.

Wooden Covers Protect Ways on Idle Planer

PLANERS are sometimes idle for long periods of time, thus leaving the ways exposed to the dust and grit of the shop, which becomes ground in when the machine is started.

One shop protects the planer ways by providing a board cover for each side. These covers have two V-blocks, one at each end, which fit into the ways. The length of the top board is the same as the exposed portion of the ways when the platen is flush with one end of the bed.

These cover boards are put in place over the week-ends or when the machine is to be out of use for any great length of time.—H. L. WHEELER.



The wooden covers have V-shaped blocks that fit into the exposed ways of the planer.

PIPE leaks may be temporarily repaired by cutting a piece about 2½ in. long from an ordinary hose, slitting it down the center, and slipping it over the pipe. Fasten it in place over the leak with an ordinary C-clamp.

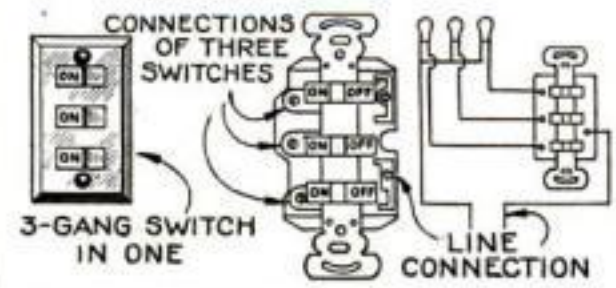
Combination Electric Wall Fittings

What is a three-gang switch and how is it installed?

GANG switches can be obtained in sets of two or three switches and in either three single-pole, one single-pole and one

Three-gang plates can be obtained that will fit into a single-space wall box.

three way, or two single-pole and one three way sets. These units take up the same space as one ordinary switch and therefore are handy for installations where old switch boxes are to be used, since no new hole need be cut in the plaster. The cable is run from the new



Sketch of the three-gang switch and diagram of connections necessary for an installation.

light outlets right to the old box, the line and fixture connections are made, and the plate is put in place.

Is there any wall device that will indicate when a fixture is in use?

The combination pilot light and switch, shown at the top of page 122, is a convenient means of telling when the cellar light is in use. The plate can be obtained in the single or double size for use in either a single or double wall box.

By installing this wall plate at the top of the cellar steps, you can tell at a glance whether you have left the light on or not.

The wiring is shown in the illustration and requires few additional connections.

Can a wall plate be obtained that combines a pilot light and receptacle?

Yes, and it is not only a genuine convenience, but also a protection against accident in the use of heating appliances.

FILES will do a lot for YOU

And they will do the most that any file can do for you if they are stamped with the Nicholson Brand.

Sharpening a saw takes a little practice but it can be readily done with a Nicholson Slim Taper File.

The teeth of the Nicholson Flat File are specially designed to remove stock rapidly.

There are times when only a Nicholson Square File will do. Filing keyways and slots for example.

THERE are any number of uses for files and Nicholson Files for all of them. "File Filosophy," a specially prepared booklet on the subjects of files and filing, will be sent to you free on request. Drop us a card or tear off the bottom of this page and mail it. We suggest that you attend to it now.

Curved surfaces are not hard to get at — with the Nicholson Half Round File.

While its main use is sharpening mill saws, the Nicholson Mill File does a first rate finishing job.

NICHOLSON U.S.A. (TRADE MARK)

NICHOLSON FILE COMPANY
Providence, R. I., U.S.A.

— A File for Every Purpose

NICHOLSON FILE COMPANY
Providence, R. I.

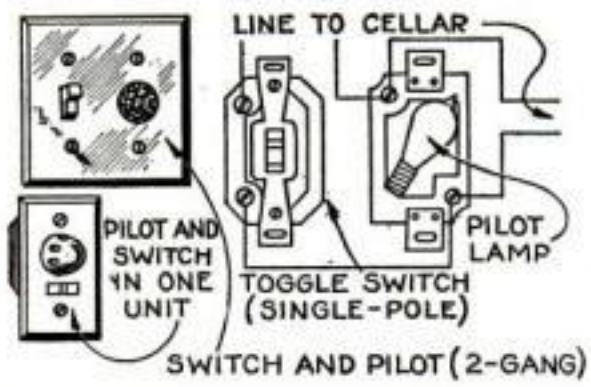
Gentlemen:

I should be glad to receive a copy of "File Filosophy." There is, of course, no obligation on my part.

Name_____

Street Address _____

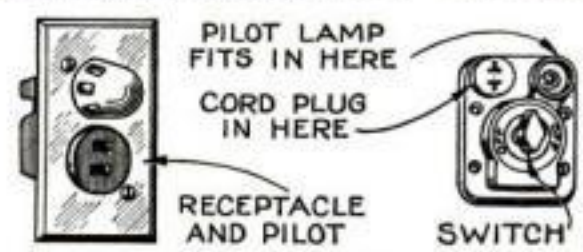
City_____ State_____



The two types of switch and pilot light combinations for use in single or double wall boxes.

The lamp tells when the current is on and thus when the appliance is in use, eliminating any possibility of burning out the element through overheating. The combination can be installed easily, a screw driver being the only tool needed to make the change, as the unit fits into any already existing single-size wall box.

A porcelain combination switch, pilot light, and plug can be obtained for use in the cellar laundry. A few screws and a little additional wiring are all that is necessary for its installation. This device



Flush and surface types of pilot and receptacle combinations. The surface type has a switch.

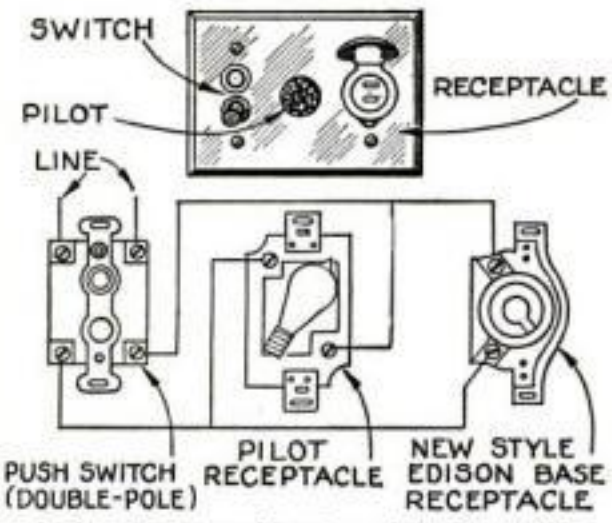
fits on a standard two-gang switch box of the surface type, making it suitable for the general surface wiring found in cellars.

Can a wall plate combination be obtained that includes a switch, pilot, and receptacle?

Three single units placed under a single wall plate form this combination (see the last illustration). A box large enough can be set in the wall by enlarging the hole made for a single wall plate. The receptacle has a protecting cover which fits flush with the plate when the plug is not in use. This is shown below.

Can the quantity of heat given off by a heating appliance be regulated?

For those who wish to control the heat given off by a heating appliance, a heat control plug can be purchased. This plug has a disk which can be adjusted to regulate accurately the amount of current allowed to flow through the element. The plug fits the standard appliance and can be readily attached to the existing cord.
—HAROLD P. STRAND.



A three-gang combination with push button switch, pilot light, and safety cover receptacle.

Tough....with a good temper

PICK a stubborn screw and see what happens when you "lean on" this Stanley "One Hundred Plus" Screw Driver.

You can easily understand why this screw driver will stand the rough use and abuse of heavy work when you read below how it is made.

STANLEY TOOLS

Here are some of the reasons why craftsmen and mechanics select the "One Hundred Plus" Screw Driver.

1. Tough Hickory Handle. Capped with leather washers, it has the same construction as used in a socket chisel to withstand pounding. Comfortable fluted grip.

2. One piece forged steel blade *tempered its entire length.* Blade will withstand severe prying and twisting strains without bending or breaking.

3. Tang has two heavy wings forged its entire length which lock the blade against turning.

4. Tips will not chip. Equal flatness on both sides reduces the tendency to turn out of screw slot.

Made in seven sizes — 3, 4, 5, 6, 8, 10 and 12 inch blades.

Ask your hardware dealer to show you this screw driver

THE STANLEY RULE & LEVEL PLANT
New Britain, Conn.

STANLEY TOOLS

"The Choice of the Trades"

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

How to Truss-Wind a Bait Rod

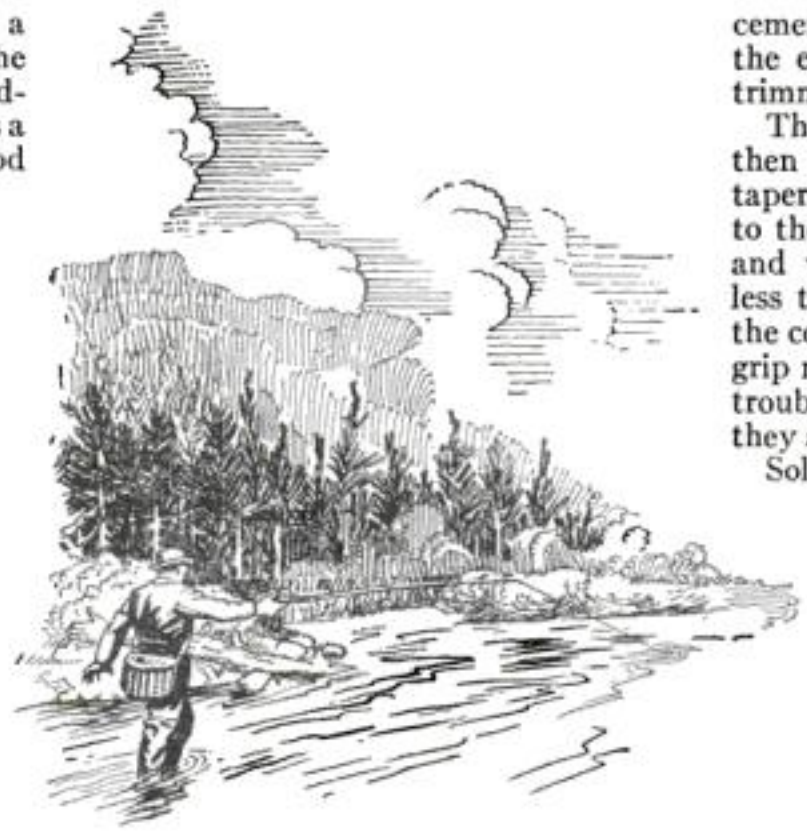
Special Silk Thread Wrapping Adds to Strength and Resiliency of a Homemade Rod for Casting

By ROBERT PAGE LINCOLN

SPIRAL winding or truss-winding a rod with silk threads is probably the most ingenious manner of rod winding open to the amateur rod maker. It is a method that not only strengthens the rod greatly but also gives it a graceful, resilient action. Solid wood tips so wound have double or triple the value of like tips wound straight across in the ordinary manner.

Two-piece rods of the truss-wound variety are considered by many fishermen to be ideal for use in bait casting for bass.

Obviously the ferrule or jointing place in this rod should not be in the middle, or too great a strain will fall upon it at that point. Rather have the tip 40 in. in length and the butt piece 26 in., the whole rod being 5 ft. 6 in. over all. If desired, the bamboo butt section can be purchased complete for approximately $5.



The rod tips can be made of bethabara, lancewood, greenheart, dagama, and many other woods, which can be obtained through any of the larger sporting goods supply companies. In every instance only the very highest quality of wood should be selected, free from knots, slivers, and other inequalities of grain.

The taper of the rod is obtained, as shown in the illustration at the bottom of the page, by supplying the dimensions at stations 10 in. apart. The butt piece is $\frac{15}{32}$ in. in diameter over its whole length.

The hand grasp and grip are made up of cork washers (untrimmed), which can be purchased from any firm that supplies rod making materials. These washers are liberally coated with rod maker's cement both on the inside and in between the corks and are then slipped on the butt section.

A wood sleeve, or filler, which can also be purchased for a few cents, is then driven up close to the cork, after which the reel seat is forced home over that. Then the corks for the forward grip are cemented in place, the cork adjacent to the end of the reel seat being carefully trimmed to fit snug.

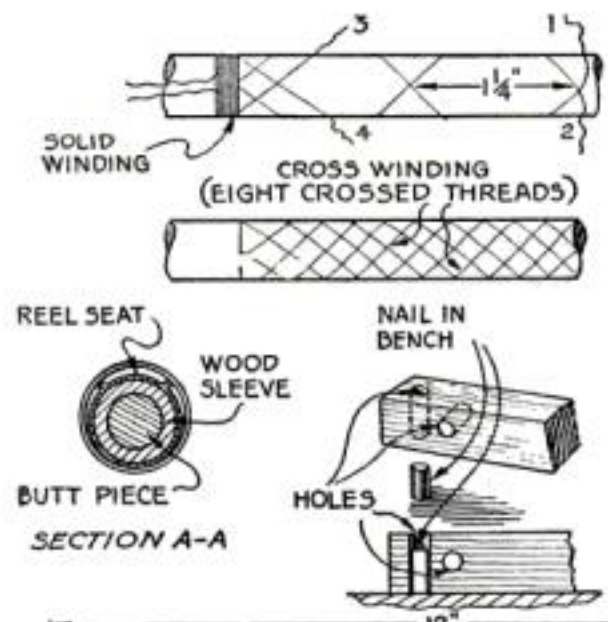
The tip end of the cork forward grip is then shaped and the winding check or taper is forced in place. Trim the washers to the required shape by means of a file and various grades of sandpaper. For less than a dollar, one may obtain both the cork hand grasp and the cork forward grip ready to slip on without any further trouble save applying cement to the wood they are placed on.

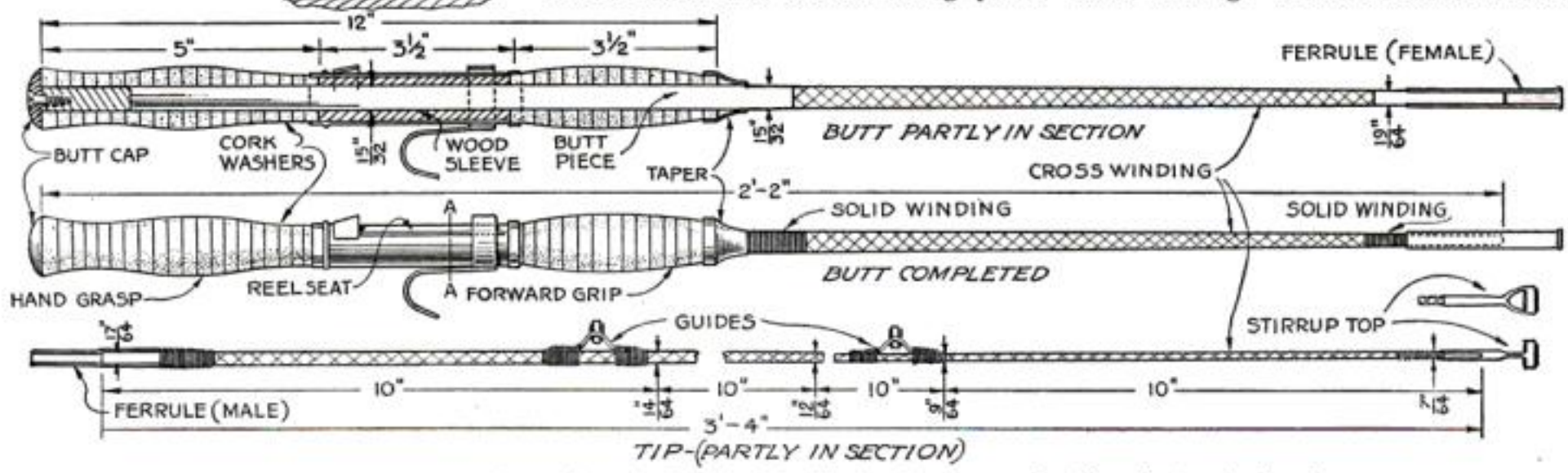
Solid wood for rods comes in ½-in. stock and has to be planed down. Cut the stick a little longer than the 40 in. for the tip piece and bore two holes near the end of it, preferably in the end that is to be the heaviest. Drive a nail into the workbench and catch the stick by placing the hole over this nail; this will be a distinct aid in planing. As you turn the piece, shift from one hole to the other.

In planing use a very sharp block plane set to cut fine. Do not plane more than two strokes on an edge before turning it, and as you get down fine use your calipers often to see that the diameter at various points compares favorably with the dimensions as given.

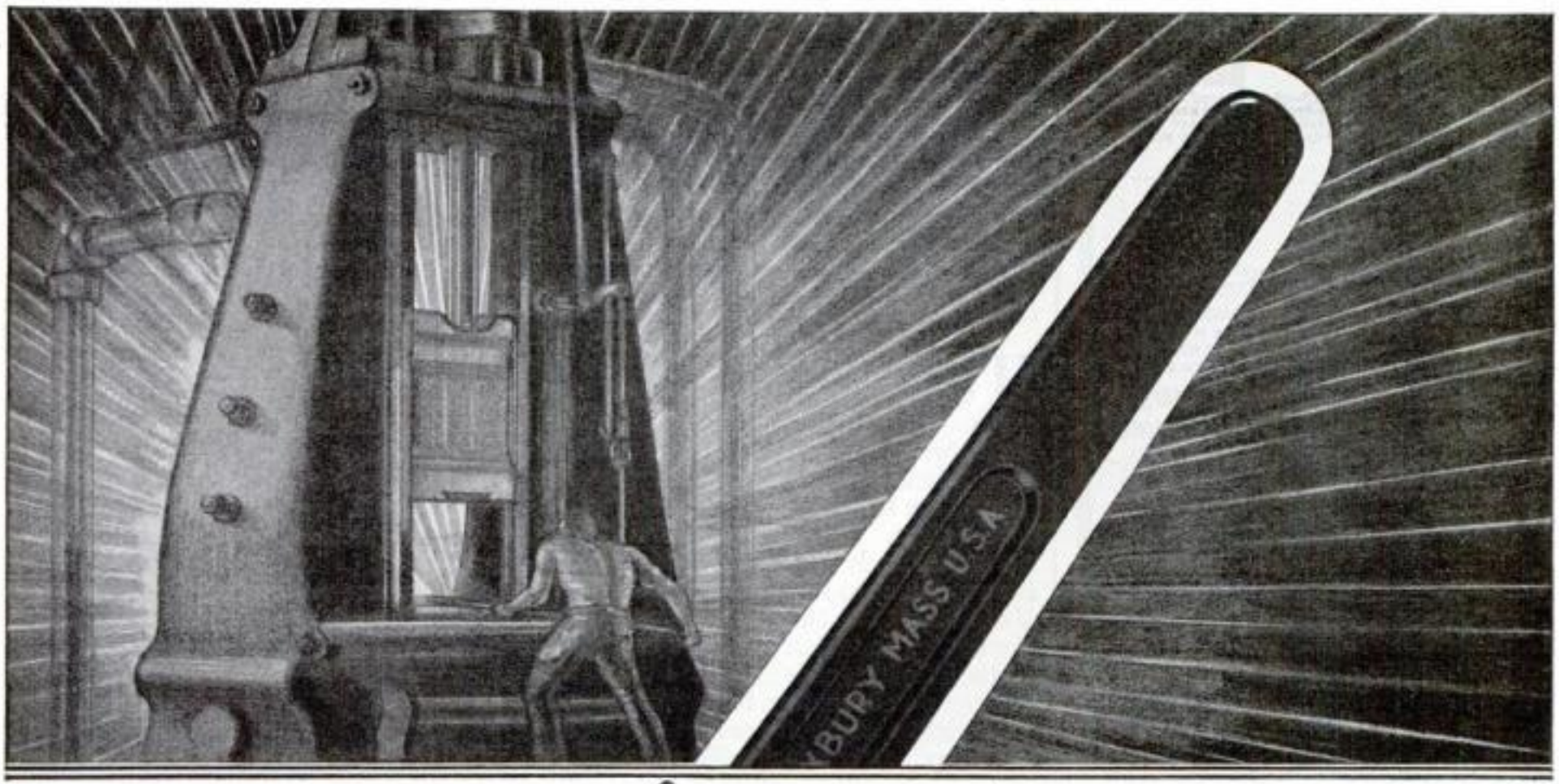
Ferrules for a rod with one jointing place should be of the capped and welted variety, $\frac{21}{64}$ in. in diameter. There are, of course, two ferrules, male and female. Two agate guides, size 2 and 3, raised, are needed, also an agate, offset, tip-top guide, and butt-cap.

In winding a rod start about an inch from the winding check or taper on the rod, just ahead of the forward grip. Eight threads are used in winding the length, two threads meeting in a V (as shown), the distance between each V being ¼ in. To start, catch in a thread as shown and start winding. The distance from where

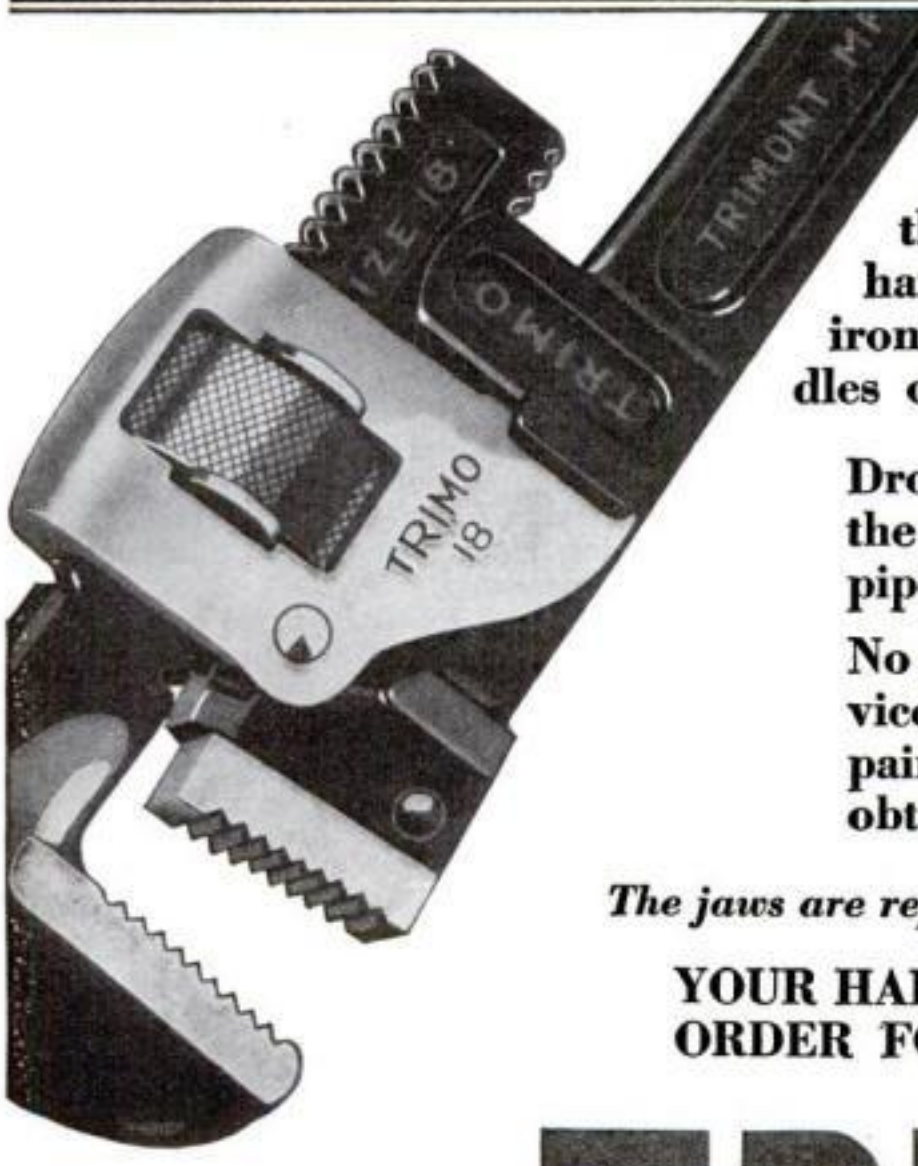




Dimensions of the two-piece casting rod. How the eight silk threads are wrapped and how the taper is planed with the aid of a nail driven into the bench. Note the wood sleeve over which the metal reel seat is placed.



Drop Forged---*Not Cast*



Knowing the inside story of the tools you use is interesting, but not as important as knowing the outward results of those inside facts. It is a fact that TRIMO handles could be more easily made of cast iron. It is a more important fact that those handles could be more easily broken if they were.

Drop forging the handle is simply one of the many inside facts of the famous TRIMO pipe wrench.

No pipe wrench made can give you more service, strength, and safety than TRIMO. No pains are spared to give you the finest tool obtainable in this All-Steel pipe wrench.

The jaws are replaceable. Nut guards keep the adjustment true.

YOUR HARDWARE DEALER WILL FILL YOUR ORDER FOR TRIMO—and approve your choice.

TRIMO

TRIMO Pipe Wrench

Ⓢ

All Steel for Strength and Safety

Made by Trimont Mfg. Co., Inc., Roxbury (Boston), Mass.

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

you start to where your thread first crosses a point directly above it is 1¼ in. This distance may be lessened gradually to an inch at the tip section.

Have your rod jointed up and as the rod is turned wind right over the ferrules, as the cross windings are made later and the truss windings across the ferrules trimmed off. In spiral winding it is of the utmost importance that the thread be kept taut from the beginning to the end.

HAVING wound your first thread to the very tip, secure it thoroughly by a cross winding so that it will not slip. Next thread No. 2 is fastened at the bottom; whereas thread No. 1 was wrapped toward the left, this second thread winds to the right. This also is carried to the tip and securely fastened. Thread No. 3 is now caught in ¼ in. to the right of the V of the first two threads and is wound to the left. The fourth thread is caught in on the left side and is carried to the right.

Keep on alternating from right to left until eight threads are carried to the tip of the rod, after which solid cross windings at the bottom of the ferrules and at the tip can be put in place. Start your solid windings in each instance at least ¼ in. up on the truss windings as shown. Do the same at the ferrule places, but do not cut the truss threads where they cross the ferrules before both windings are in place. A solid winding both above and below the male and female ferrule of no less than an inch should be made, likewise at the tip of the rod, as it is necessary that the truss threads be held very firmly in place.

When your solid windings are completed your guides can be laid on. It is a good idea to spread a little varnish where the guides are to be and set the guides in this and let them harden into place, then wind the thread around each end. By applying the varnish underneath, the moisture has no chance to get at the truss threads.

Apply your varnish of the rod making sort heated to a lukewarm state and work in a warm room free from dust. Go over the rod thoroughly and then hang up to dry. Three weeks is not too long for the first coat to dry, when successive coats can be applied till the diamond squares between the truss threads are more or less filled up.

Under no circumstances bend the rod till you have completed the last varnishing. Three coats are sufficient but more can be applied as occasion demands, especially after each fishing season.

Regluing Loose Joints

WHEN only a joint or two is loose in a piece of furniture, it is usually possible to spring the parts far enough apart to insert glue and then bind them together or clamp them until the glue has hardened. If possible scrape off the old glue before applying new glue. Vinegar applied vigorously with an old toothbrush often will remove the old glue. If the joint is very loose, use plastic wood cement instead of glue, as glue itself will not hold a loose joint. Remove the surplus glue or cement with a cloth moistened with warm water.

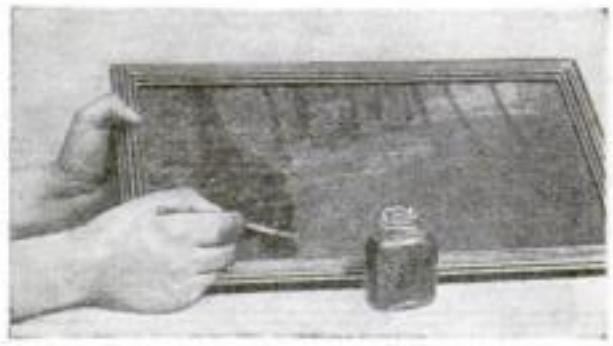
How to Rejuvenate Old Oil Paintings

OIL paintings that have been hanging for a number of years sometimes become dull and lifeless. Such paintings can be quickly brought back to their former clearness by cleaning and then brushing with a special picture varnish.

In cleaning, care must be taken. Use lukewarm water and only the best soaps. Dip a lintless rag into the soapy water and carefully wipe off all the dust and dirt. The picture should then be allowed to dry thoroughly.

One of the best varnishes for doing this sort of work consists of sandarac gum, denatured alcohol, and ozonized turpentine.

To prepare such a varnish, place the sandarac gum—an ounce will be more



The varnish is applied with a soft brush and is spread over the entire oil painting.

than enough for all ordinary purposes—in an 8-oz. bottle. Fill the bottle three quarters full of alcohol and then add about two teaspoons of ozonized turpentine. Ordinary turpentine cannot be used since it is insoluble in alcohol. Shake the bottle and keep it in a warm—not hot—place until most or all of the gum has dissolved.

This varnish is applied by means of a soft brush and is spread thoroughly over the entire painting. If one application of the varnish is not enough to give it a high gloss, a second and even a third coat may be necessary.

If these steps are carried out with care and patience, even the best painting will not be harmed by this method of renovation.

This special picture varnish can also be used for retouching scratches on the surfaces of furniture.—H. BADE.

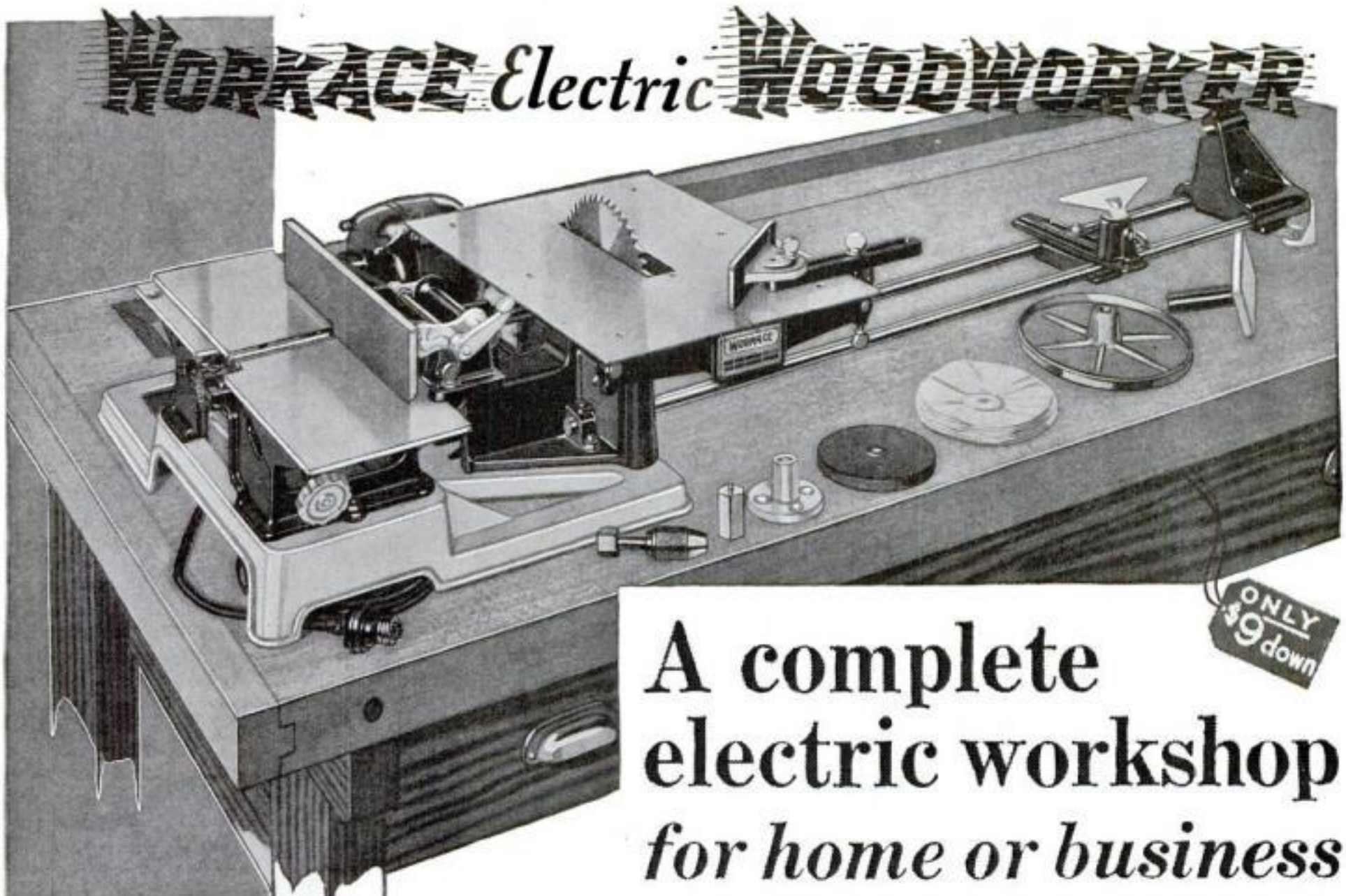
Grinding Soft Rubber

THOSE who have tried it know that while hard rubber can be ground to shape on an ordinary emery wheel, it is practically impossible to shape soft rubber in the same manner.

This difficulty can be overcome by using an emery wheel having square teeth cut into its surface. These teeth should be ¾ in. wide and should have a pitch of 1½ in.—H. W. SWOPE.

TO REMOVE old putty from window frames, use a chisel about 1 in. wide. Incidentally, a chisel of this size is a good one to keep on hand for general work. Care must be exercised not to allow the chisel to cut into the wood. If the putty is set very tight, there is danger that pieces of wood will come off with the putty.

WORKACE Electric WOODWORKER



ONLY $9 down

A complete electric workshop *for home or business*

EVERY man who has a workbench has often wished for a complete outfit of power driven woodworking machinery. Such a workshop is now as easy to possess as a radio set, and costs much less.

The Workace Electric Woodworker — a complete all-electric shop — costs but $9.00 first payment and $9.00 a month. This includes power driven tools for every woodworking operation.

Jig Saw Attachment for the Workace Electric Woodworker..... $10

14" Workace Band Saw, fast, accurate, economical..... $75

Low Price $89 Easy Terms

Here's a hobby that gives you relaxation from everyday cares —bringing pleasure and profit. Thousands of men and boys have adopted the Workace hobby. Make hundreds of things with the Workace Electric Woodworker. Under the magic of the whirring saw, planer, lathe, sander, drill, grinder and buffing wheel (all are included in the Workace Woodworker) raw lumber is easily converted into furniture, household necessities and countless other articles. Work out your own ideas with your own complete electric workshop. There's no better gift for the growing boy than Workace. It provides a wholesome man-building outlet for his energy and enthusiasm.

includes all this:

- 4" Planer
- 8" Circular Saw
- 6" x 36" Lathe
- 8" Disc Sander
- 6" Buffing Wheel
- 5" Emery Grinder
- ¼" Drill Chuck
- ¾ H. P. G. E. Motor, 110-Volt, A. C., 60 Cycle

Endless V-Belt, 4" and 2¼" V-Stepped, Pulley, Cast Iron Sub Base and 10 ft. Cable with separable Plug.

The Planer and Circular Saws are each complete units and may be purchased separately at the correspondingly low price of $25.00 each.

A down payment of $9.00 brings you the complete Workace All-Electric Woodworker ready to set up and use right away. The entire transaction is handled by one of your local hardware stores so that you will know the man you are dealing with and get his service and cooperation.

The Wallace Guarantee assures replacement of defective parts.

Large reproduction

For every coupon mailed in we will send a large picture of the entire outfit and a complete description of each item.

Send for full particulars and we will refer you to our dealer who is nearest to you.

Workace Radial Saw, sets at any angle $140
Cast Iron Table $10 Extra
Cast Iron Legs $15 Extra

Workace high speed, direct drive, portable Electric Shaper..... $95

MAIL THE COUPON TODAY

J. D. WALLACE & COMPANY,
Wilcox St. at California Ave., Chicago
1 West 42nd Street, New York City
268 Market Street, San Francisco

Please send me large size photograph and particulars about the Workace Electric Woodworker. Also interested in ☐ Jig Saw— ☐ Band Saw — ☐ Radial Saw — ☐ Shaper — ☐ Planer.

Name.....

Firm.....

Address.....

Consult telephone directory for branch addresses in other cities

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Unusual Pipe Mount for Telescope

Homemade Pedestal Built Entirely of Standard Fittings and Two Auto Axles

By C. A. HOWARD

Pipes and standard pipe fittings were used in constructing this unique, easily adjusted telescope mounting.

PROBABLY few readers have ever associated gas pipe and astronomical research in the same channels of their minds. These have been associated, however, and out of this thought has grown an efficient and durable telescope mounting.

The mounting illustrated was made by the writer and is now in use on the grounds of his home in Dallas, Texas.

The telescope is the largest in the extreme southern part of the United States. Many distant stars and planets have been clearly seen and photographed, including the great ringed nebula in Lyra and the belts and red spot on Jupiter.

The pedestal consists of a 6-in. diameter nipple, 30 in. long, having a cap on the upper end and a standard 6-in. flange on the lower end. The flange is securely bolted to a foundation of concrete, and a 2 by 2 in. two-strap pipe saddle is welded to the cap to provide a fastening for the 2-in. pipe-bend return which is 12 in. from center to center.

On both ends of this return bend are attached two 2-in. extra heavy tees. The threads on the run of these tees have been milled out smooth to receive the polar axis, which consists of a Ford rear axle housing, including the shaft, roller bearings, brake drum, and brake shoe. The differential housing, however, is not used.

On the hub of the model-T Ford axle is welded another 2-in. tee with the threaded portion milled-out smooth.

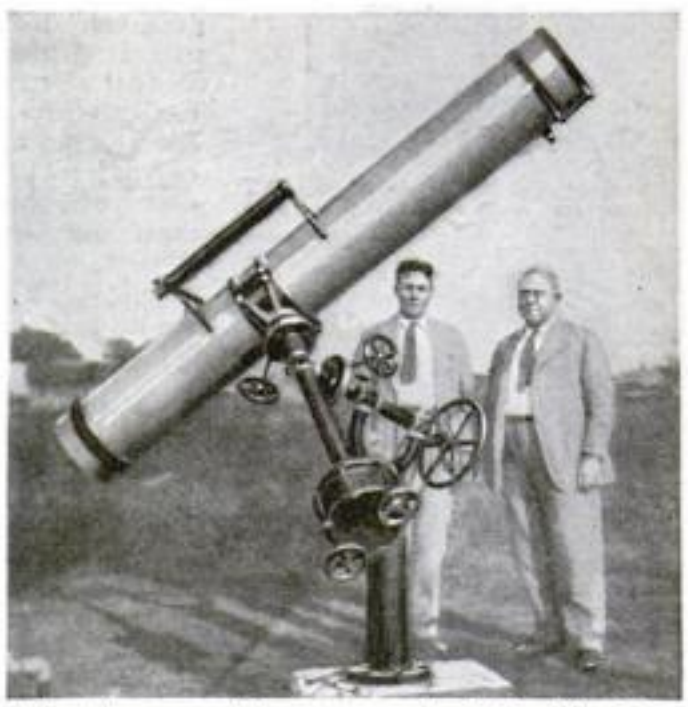
The declination axis is made from another Ford axle. On the lower end of this axis is welded a 2-in. floor flange to receive the counterbalance, which is a 10-in. dresser type coupling faced on each end with ⅛-in. metal disks and filled with lead to offset the weight of the telescope tube.

Pressure is applied to the brake drums by operating the emergency brake rods. The rods are threaded on the end and wheels from two 4-in. gate valves are tapped and attached. Between the drums and the wheels are placed pieces of ⅜-in. pipe. As the wheels are turned in the tightening direction, they bear against these short sections of pipe and pull the brake rods, thus applying the pressure.

Inside, at the lower end of the telescope tube, which is made from 16-gage galvanized iron, is placed the mirror. The mirror shell has a 1-in. angle iron flange riveted on its outer edge. The end of the telescope tube has a similar flange supplied with holes for the attachment of the speculum shell.

On the back of this speculum shell are the adjusting screws which enable the cone of light to be trained on the prism suspended at the other end of the telescope tube. For the remainder of the instrument, regular optical astronomical equipment is used.

At the present time, the writer and Dr. A. D. Laugenour, his coworker and incidentally the codesigner of this telescope mounting, are hard at work studying the craters in the moon.



The telescope and the two men who designed it, Mr. Howard (left) and Dr. Laugenour, his coworker.

1000 Uses

FILL nail holes . . . glaze windows . . . set castors, screws, handles, fixtures, chair rungs . . . use in building ship models . . . auto repairs . . . seal holes around pipes . . . build up wood surfaces . . . seal cracks in floors, doors . . . patch plaster walls . . . weatherproof leaky window frames . . . make baseboards tight . . . mend furniture . . . set tiles . . . repair mouldings.

NON-INFLAMMABLE

Just What You've Been Waiting For!

A Crack Filler that WON'T SHRINK

IF YOU want to make repairs that *stay put*, use Savogran Crack Filler.

For filling cracks and holes, building up wood surfaces, and all sorts of general repair work, there's nothing like it. Savogran Crack Filler is so easy to work with that when you've finished one job you look for the next. It has great adhesion. It takes paint perfectly—does not show through like a puttied hole even when finished with a stain. And best of all, Savogran Crack Filler won't shrink. The places where you have used it defy detection.

No work-bench is complete without a can of Savogran Crack Filler. Try it once and you will never be without it. *Note the price* of this superior filler and send for our introductory can right away if a near-by paint or hardware store cannot supply you.

Savogran Crack Filler is a product of the Savogran Company, India Wharf, Boston, Mass., makers of the famous Painters' Savogran. Painters' Savogran has been used by painters and householders for more than 35 years because it saves them time and money. Painters' Savogran softens the hardest paint-brush and makes it usable again, cleans dirt and grease like magic before repainting, removes paint and varnish, strips off ground-in dirt without scrubbing. If you do any painting—get acquainted with Painters' Savogran.

SAVOGRAN CRACK FILLER

PATENT APPLIED FOR

Big One-Pound Can

A POUND of Savogran Crack Filler costs you only 30 cents. For painters, woodworkers, industrials, and other large users, Savogran Crack Filler is supplied in 5-lb. cans ($1.25) and 35-lb. all-metal pails ($7.70). Low price—no hardening in the can—no waste—here is the biggest value on the market.

Only 30 CENTS

Special Offer

To make new friends everywhere for this popular filler we will send you a quarter-pound can of Savogran Crack Filler on receipt of 10 cents. Use coupon.

(COUPON)

SAVOGRAN COMPANY, India Wharf, Boston, Mass., Dept. S3
Send me a ¼-lb. can of Savogran Crack Filler at your Special Introductory Price. I enclose 10 cents.

Name.....

Address.....

Famous Ring Test Proves Non-Shrinking

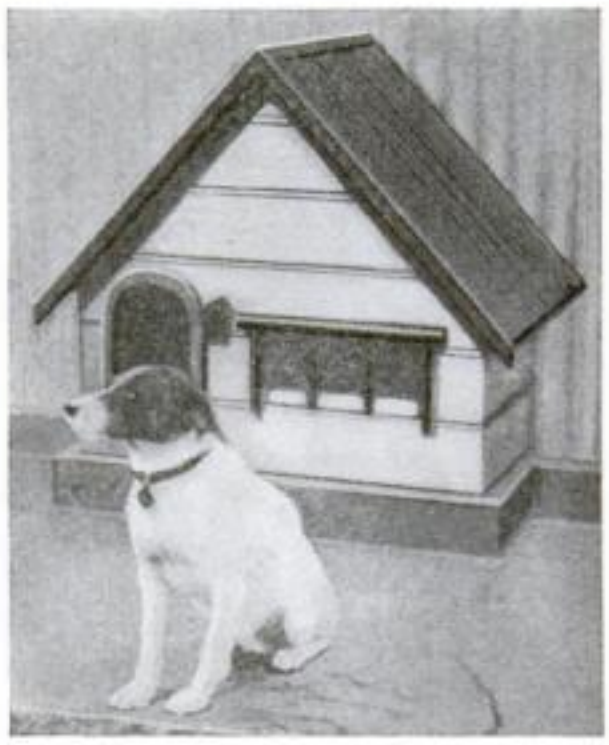
S Savogran Crack Filler — **X** Competitive Material

Two steel rings were filled and allowed to dry. Here are the unretouched photographs showing what happened. *Above*—Rings at the end of first day. Savogran Crack Filler tight as a drum. "X"—considerable shrinkage away from ring.

HERE are photographs taken at end of three days. *Above*—"X" so badly shrunk that it drops out of the ring completely. *Below*—Savogran Crack Filler tight as ever.

Mirror photograph shows great pressure being applied without dislodging or moving the filler. Savogran Crack Filler *stays put!*

Make this sensational test yourself!



Reader Builds Dog a Modern Home

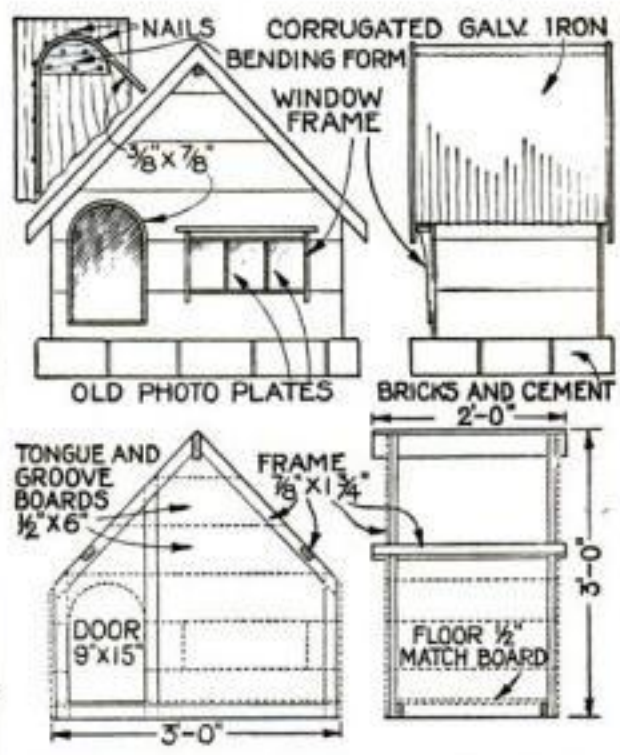
FEW dogs can boast of having a residence as fine as the one built by G. O. Lawrence, of Semaphore, Adelaide, South Australia, and pictured above.

Figuratively speaking, the house has all the conveniences of a modern home. As Mr. Lawrence expresses it in his letter, "Our dog is a very happy one, and with a little patience we hope to train him to turn the light on for himself so that on dark nights there will be no danger of his tripping over the doorstep!"

Bricks and cement form the foundation. The wooden framework is built of ⅞ by 1¾ in. stock, the walls are of ½ by 6 in. tongued and grooved boards, and the window has three lights made from 4¾ by 6½ in. photographic plates.

Just outside the door is a small ornamental bracket lamp with glass windows. It is lighted by means of a two-volt dry cell.

The house has proved to be wholly satisfactory. Perhaps the principal reason is that the wooden frame is not attached to the foundation, and the house therefore can be cleaned and aired easily.



Front and side views of frame and also of completed house. Method of bending doorframe.

Modernistic Radio Cabinet

By

RICHARD H. SPESSARD

Space is provided in the cabinet for a radio set, loudspeaker, phonograph, and library of records.

FOR the amateur woodworker who wishes to build furniture of the newer trend, this combined radio and phonograph cabinet has the merits of novelty and utility. It affords ample room for most types of receiving sets as well as space for a phonograph and records. Painted in well-selected colors, it can be brought into harmony with the existing color scheme of the room in which it is to be placed.

The original cabinet was built to receive an all-electric phonograph with a motor-driven turntable and an electric pick-up. This type of phonograph was chosen for its tonal qualities and because it is possible to regulate the volume to any degree desired. The radio set used by the writer is a popular priced all-electric set having a long air-column speaker.

If you desire to use a battery set with a cone or dynamic speaker, however, there will be plenty of room for them. A spring-wound motor from a discarded phonograph will work satisfactorily in case the builder wishes to cut down on the cost of the outfit.

To keep the cabinet light in construction, a light wood such as yellow poplar should be used; it has the added advantage of being easy to work and will take paint evenly.

The cabinet proper consists of the radio and speaker compartments. The top, sides, shelf, and bottom are made separately of narrow tongued and grooved boards, which are glued together. To add rigidity, the speaker compartment is backed solidly with planking. In case a power amplifier is installed, a hinged door with an additional shelf can be provided.

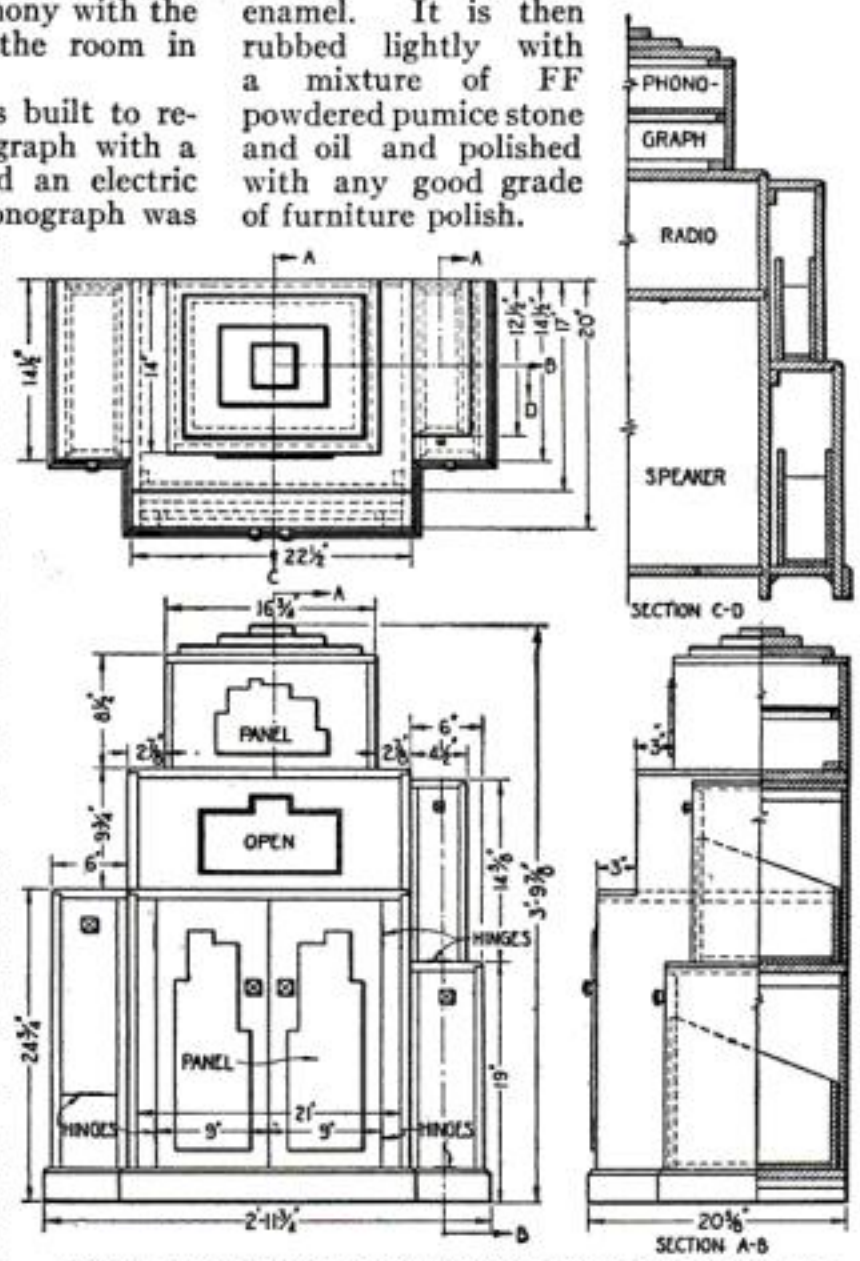
The record compartments are first built and then attached to the cabinet with screws started from the inside of the speaker cabinet. When the compartments on both sides have been completed, the molding can be mitered around the bottom.

Like the record sections, the phonograph compartment should be made separately and screwed fast to the main cabinet. The top is hinged in the rear with one long hinge and is provided with a lid catch to support it when open.

The doors for the main cabinet each consist of a single-width board. They are hinged and have a friction catch at the top.

The grille work in front of the speaker is plain in design to harmonize with the angular scheme of the cabinet. It is made just the size of the door opening and is held in place with screws at the top and bottom.

The completed cabinet should be sandpapered and given three coats of paint and later a coat of clear varnish or one coat of undercoater and two of enamel. It is then rubbed lightly with a mixture of FF powdered pumice stone and oil and polished with any good grade of furniture polish.



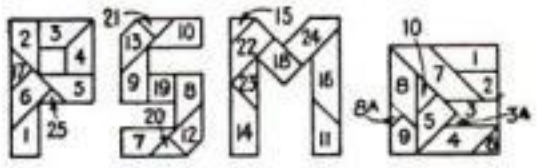
Yellow poplar or other easily worked wood is desirable for the construction. The radio section may be modified as necessary.

Easily Constructed Block Puzzles

WHILE little difficulty should be encountered in constructing the parts that go to make up the two block puzzles illustrated at the bottom of the page, the solutions are of a type to keep your friends guessing a long time.

Below are given the solutions to the two puzzles of a similar character which appeared in P.S.M., Feb. '30, p. 117.

The two new puzzles can be made from either ½ or ¾ in. square stock. In shaping the pieces, cut them in numerical order, making all cuts at right angles to the bottom face of the stock and at either right angles or 45 degrees to the sides as indicated. In the cross puzzle be sure that the points on the left-hand side of pieces *7* and *9* are in the center of the side (see illustration).



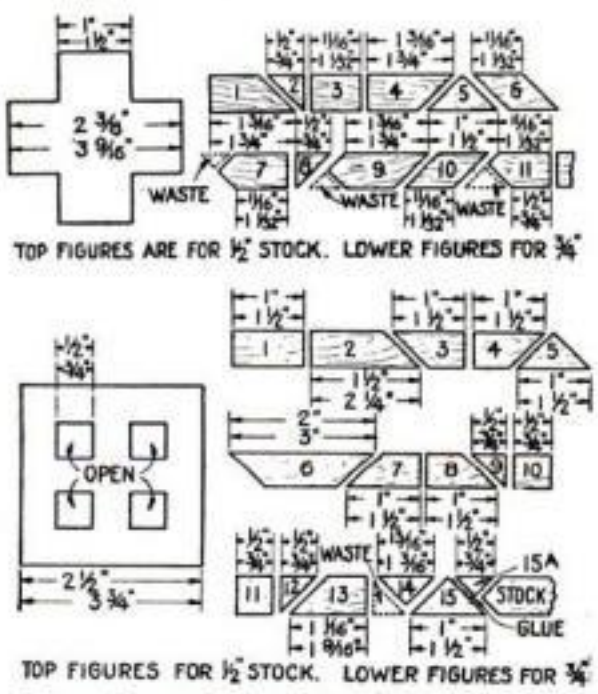
Solutions to the two puzzles which appeared in the February issue on page 117.

Take particular care in cutting pieces *13*, *14*, and *15A* of the square puzzle. Piece *13* is slightly longer than *7* or *8*, and *15A* is half the size of *9* or *12*. Be sure that piece *15A* fits on piece *15*, as these must be glued together.

Number all of the pieces as shown and stain each puzzle set a different color so that they can be easily identified. Since these puzzles are solved with all of the pieces right side up, it will be an advantage to stain only one side of each piece.

In solving this type of puzzle, a full size outline drawn on a piece of paper or cardboard will serve as a pattern over which the pieces can be placed.

Next month the solution to these two puzzles will be published.—E. B. ROBERTS.



Dimensions and plans for cutting the ½ or ¾ in. square stock for the two new block puzzles.

If enough readers request it, more puzzles of this type will be published. Address all requests to the Home Workshop Editor, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York City.

Reader Builds Concrete Garage

ANY reader who has had some experience with concrete work will be interested in the unusual examples of cement construction shown. They are the work of D. H. Frew, of Lisbon, Ohio, an editor and publisher.

The garage was made from concrete panels 1 in. thick and 8 ft. long, which were molded in sheet iron pans. Iron molds were used to give a denser and smoother finish; in fact, the blocks are practically waterproof. These panels are set in between 4 by 5 in. concrete posts.

The garage was built four years ago and is at present without the slightest crack or flaw.

This garage, which was built for Mr. Frew's own use, has been standing for four years and is without a break or a flaw.

Each step was built in three molded sections, two pieces for the base and one for the tread.

The steps shown were built for a library building in Mr. Frew's neighborhood. Each step was made in three pieces, two pieces for the base and one piece for the tread. The treads were poured into a mold reënforced with iron rods, and troweled smooth after a little marble sand had been sprinkled over the top surface.

Boiler Injector Removes Water from Cellars

STORM water and seepage can be easily removed from cellar floors located below the sewage drain by the ingenious application of a steam boiler feed water injector.

First, break through the flooring at the lowest point, place a 100-lb. white lead or similar can flush with the surface of the floor, and cement it securely in place. This forms the well for the drain water.

Obtain a ¾-in. steam boiler feed water injector and pipe the outlet of this to the sewage drainpipe.

Run a pipe from the intake of the injector up to the ceiling and then down to the well in the floor. This is done to obtain the added effect of a siphon system.

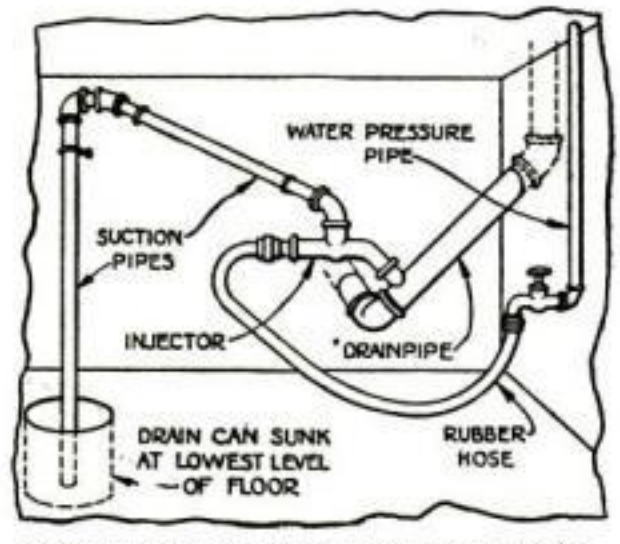


Diagram showing relative positions of the injector, water faucet, drain, and drainage well.

Next, connect the pressure inlet to a water faucet by means of a piece of rubber hose held in place with clamps.

To operate, all that is necessary is to turn on the water at the faucet. After the injector has been working awhile the pressure may be cut down, as the siphon action created in the intake pipe will tend to continue the flow of water.

This idea was put to use by the writer to remove the storm and seepage water from a garage boiler room which was located 2 ft. below the level of the sewage drain.—ROBERT D. PEEBLES.

Building Model Airplanes

SUCCESS in model airplane construction depends, as in all crafts, not only upon the skill of the worker but on the tools that he uses. The novice, especially, will find that a set of a few specific tools will simplify and improve his work.

A sharp pocketknife and a block plane having a 1-in. blade are probably the most important parts of the plane builder's tool kit. Two pairs of pliers, one round-nosed pair and the other of the flat-jawed type, will aid greatly in bending wire into form, as in assembling landing gears and making wing clips.

Among the miscellaneous tools are a large variety of sandpaper, a steel scale, an assortment of straight pins, a lead pencil, a small camel's-hair brush, and a supply of model airplane builder's cement.—A. L. JACKSON.

CLOGGED plumbing fixtures are in many instances the result of carelessness. Dirty dishwater poured into the kitchen sink adheres to the walls of the trap and waste pipe. The coating of grease, together with other matter such as coffee grounds, and tea leaves, will block the drain.

Toothbrush Holder Fosters Tidiness

CHILDREN are less likely to forget their three-times-a-day duty and are encouraged along the lines of tidiness if they are provided with the attractive little toothbrush holder illustrated.

The design can be cut from a ⅜ by 5 by 7⅜ in. piece of soft wood, since the figure is 7¼ in. high and 5 in. wide. If cigar box wood is used it will be necessary to glue a small strip across the back, along the section marked for the hooks, so that the screw ends will not come through and scratch the wall.

The figure is sawed from a piece of ⅜-in. wood.

The figure can be painted with artists' oil colors mixed with interior flat white paint to obtain the tints. This will produce a flat finish.

If desired, enamel can be used for the coloring. In this case it will not be necessary to varnish the holder, and it will be readily cleanable.—ALBERT KOHLER.

Mending Broken Pieces of Earthenware

BLACK iron enamel of the best grade forms a very efficient cement for use in mending many small crocks or pieces of highly prized china.

First, dry the piece of crockery or earthenware to be mended thoroughly. Apply the enamel to the crack with a thin piece of wood shaving, being careful to spread it on evenly all along the cracked edge. After a coat has been applied, rub the enamel into the crack.

Allow this to dry and then apply a second coat. For an ordinary crack two applications will be sufficient. If the crack is large, however, three or four coats of enamel will be necessary.

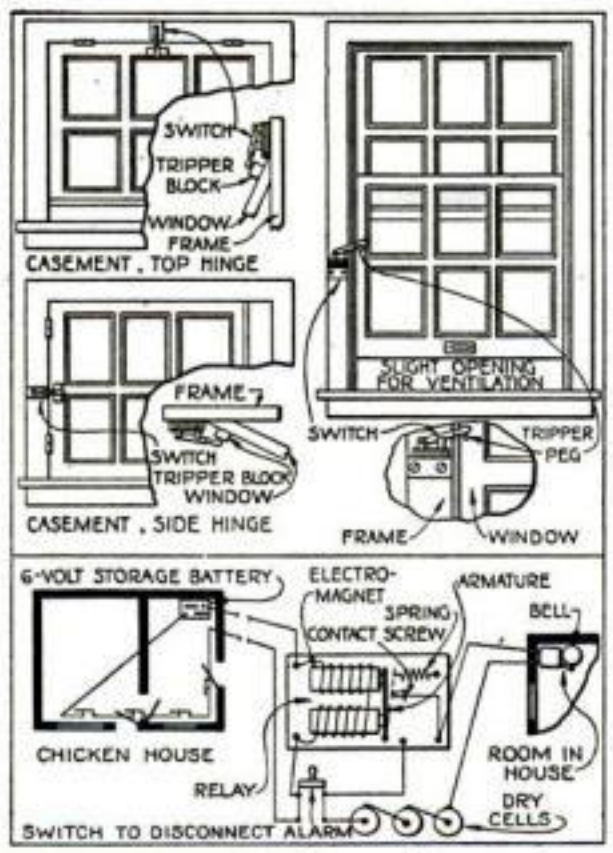
After the final coat of enamel has dried, remove any surplus with a rag dampened with gasoline.—H. W. SWOPE.

Wiring a Building Against Burglars

BY INSTALLING a simple electric alarm of the type illustrated, you can efficiently protect a garage, chicken house, barn, or similar building against burglars. Even if the wires are cut by the thief the alarm rings.

The system operates on a closed circuit which holds a relay open until the circuit is broken or a short circuit occurs, whereupon the alarm is sounded.

Each window or door is supplied with a tripper so arranged as to open a small knife switch when an attempt at entry is made. The tripper device can be placed in such a way that the window may be left slightly open without causing the alarm to sound; but as soon as the window is opened far enough to admit the body



If the window or door is opened far enough to admit a person, the relay circuit is interrupted.

of a man, the tripper throws the switch, breaking the relay circuit.

If a constant ringing bell is used, the alarm will continue to ring even though the opened window or door is closed quickly.

Fuse links can be inserted at suitable places in the relay circuit, if desired, to cause the alarm to ring in case of fire.

The materials needed are a 6-volt storage battery, a 200-ohm line telegraph relay, a 10-ampere, 250-volt knife switch, three dry cells, a 2½-in. vibrating stroke or constant-ringing bell, sufficient No. 14 weatherproof wire for outside wiring and No. 18 annunciator wire for inside, and about 200 insulated ¾-in. wire staples.

If the line running from the house to the outside building is to be buried, however, a lead covered wire should be used to insure absolute protection against moisture.—RAYMOND R. STEWART and EMORY W. BRYAN.

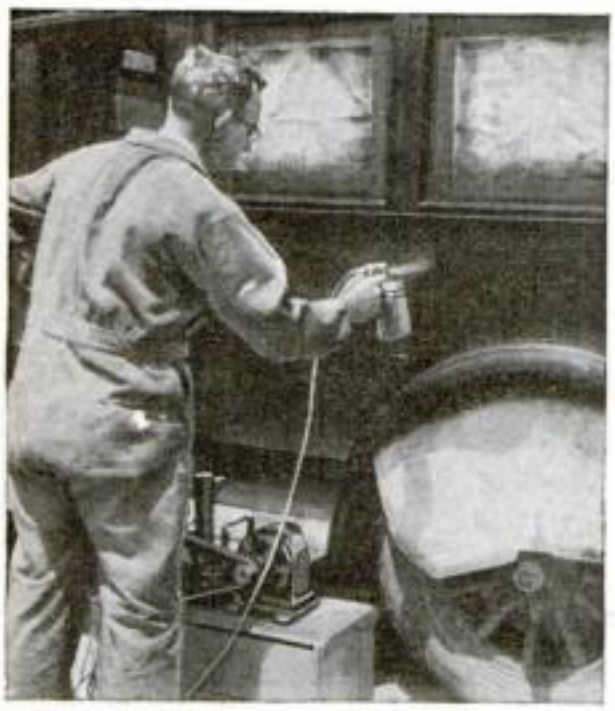
IN REPAIRING plaster walls, large patches of plaster will hold better if common nails are driven into the wood studs or laths. Sink the heads below the surface of the wall.

Using a Spray Gun to Refinish an Automobile

By EVERETT EAMES

NEATNESS and cleanliness spell success in refinishing an automobile with a small motor-driven spray gun. This is true in the preparatory work (P.S.M., Feb. '30, p. 106), and even more so in the actual application of the priming coats and the finishing lacquer.

Start with the hood, which should be set up on an old table or box and given another good washing with benzol. Do not run over the surface hurriedly, but rub it hard. After it seems as though no dirt could possibly be left, rub the whole surface with a lintless cloth dampened with thinner. During the cleaning, remember that the edges and seams require the most attention.



The sprayer should be held at about 8 in. from the work and kept in motion at all times.

Mix a pint of rust inhibitive red oxide of iron with a pint of thinner and fill the jar of the spray gun three quarters full. Start the motor and try the spray against a piece of tin. If the mixture is of the right consistency, a smooth, even coat will be deposited. A lumpy or pitted surface indicates that the liquid is too heavy and should be cautiously thinned further. If it sags or runs, it is too thin and more primer should be added. Now spray the hood all over the outside, keeping the spray constantly in motion and held about 8 in. from the surface. Move the spray at an even speed back and forth horizontally and keep it pointed directly at the surface at all times. Start the gun in operation away from the work and swing it on while spraying. Lap each parallel deposit about one quarter over the previous stroke. Never stop the gun abruptly on the work; swing it away so that any necessary joining of sprayed surfaces will be "feathered."

Do not be startled by the appearance, as the correct color is bright orange. Allow the primer to dry one hour and inspect for "wet spots." If there are only

a few small shiny places (½ in. in diameter or so), they may be overlooked because they will disappear as more of the finish is applied. If there are many spots or streaks, or one or two large spots, wash off the whole coat of primer with the thinner and scrub again with benzol and thinner. When judgment of cleanliness has been developed, apply the primer over the entire body.

Between each filling of the paint jar, it should be half filled with thinner,

The hood is used as the object for all first attempts as it can be easily refinished if necessary.

shaken, and operated a few seconds to flush out the tubes and nozzle. If the gun does not discharge freely, partly clogged tubes are to blame; do not turn it against the car again until a full spray is delivered. It is well to have three or four extra mason jars on hand, one for clear thinner and the others for different colors.

Do not apply a heavy coat of primer—just enough to cover the metal thoroughly. Allow it to dry at least an hour and sandpaper lightly with No. 280 paper or equivalent, using the paper dry.

The hood may now be given three coats of surfacer, each coat following the other at intervals of at least twenty minutes. The surfacer behaves somewhat differently and is harder to lay evenly on account of its quicker drying qualities. Special pains must be taken to dilute it sufficiently to prevent the formation of a rough "orange peel" surface. A little over fifty percent of thinner will be required.

It is advisable not to stop the gun until the jar of material is completely sprayed, otherwise the tubes will clog slightly. If this happens, spray some thinner through the gun. After learning how on the hood, proceed with the body. Do not be disturbed if the coat looks somewhat rough in spots; the sanding operations will eliminate all traces of such unevenness. However, it saves labor to lay the coat on smoothly in the first place.

Now go over the surface for visible file marks or depressions and fill them with glazing putty. This should be allowed to set overnight and then scraped and sanded flush with the surface. The car should now be given a water sanding with waterproof sandpaper. Under the paper

hold a piece of folded cloth, and keep it well soaked with water. Rub rather gently, making only three or four passes over any one spot. To check the smoothness of the surface, rub the fingers along the sanded parts as the work proceeds and resand all places that do not feel glass smooth. If any spots are rubbed through, the place should be resprayed after washing with gasoline and a cloth dampened (not wet) with thinner.

The whole car should now be washed with gasoline and wiped with a lintless cloth to prepare it for the lacquer finish coats. Three coats are required, using a fifty percent dilution.

If two colors are being used, spray the upper one first and then cover it with paper bound on with masking tape. Spray the other color in the same manner as the first. If a molding strip is to be still another color, cover the surface on each side with the tape before spraying. Do not attempt to peel the tape off for at least two hours after the last spraying, and then only after thoroughly soaking it with water applied with a paint brush. This will prevent any of the finish being lifted off with the tape.

THE whole car is now to be sanded again with No. 280 paper soaked in gasoline and held over a cloth pad as before. Sand gently and make strokes "every which way" until a glasslike surface is obtained. Wash thoroughly with gasoline and give another sanding with No. 400 paper. Wash again with gasoline and wipe clean of all free color which has been sanded off. Spray on two coats of retarder thinner. This will smooth all traces of unevenness in tone and leave a natural gloss, which may be further heightened with any of the standard auto polishes compounded for use on lacquer finishes.

To refinish the wheels, sand with gasoline and waterproof sandpaper just enough to smooth the old finish unless the coating is badly flaked off, in which case the entire finish should be removed. Spray on three coats of finishing enamel, several varieties of which are available in quart sizes.

To complete the work, spray the underparts of the fenders with two coats of black lacquer; an inexpensive enamel will do if diluted with turpentine. The top should be painted with a brush in the regular way; that is, brushing lengthwise and using the dressing just as it comes from the can. If any work is required on the inside of the car, use a brushing lacquer on the instrument board and spar varnish for the molding around the windows. If any striping is required, the car should be taken to a professional striper, as a steady experienced hand is necessary for this finishing touch.

As a precaution against the chipping of the finish, run a safety razor blade along the edge of all metal moldings before the finish has thoroughly set. Cutting down to the metal in this way will prevent any slight movement of the parts from breaking the glass-hard lacquer surface. Save any small portions of material left over, as they will come in handy to retouch scratches or scraped fenders.

Mystify with Musical Cartoons

By GERALD E. HENDRICKSON

FOR the amateur artist who wishes to perform a novel stunt in home entertainment, "musical cartoons" are something new, amusing, and mystifying, yet may be performed without special talent or previous training. In fact, an hour or so spent in preparing the materials will insure a hit on any program.

The performer stands blindfolded on the stage or platform beside a sketch board upon which is thumb-tacked a number of sheets of white paper. Simply by brushing a cloth over the surface, he causes pictures to appear in instant illustration of popular song numbers played on the piano by someone chosen from the audience.

The necessary materials are a dozen or more 18 by 24 in. sheets of semiglossy paper (newspaper), a sheet of heavy wax paper of the same dimensions, and a 20 in. square piece of black cotton cloth which has been impregnated with powdered graphite.

In preparation, the performer makes the simple sketches in pencil lines to the actual size desired, illustrating the songs to be used. The drawings need not be perfect in detail, but can be rough cartoon sketches. These are the master or pattern sheets from which your blank sheets for stage use are made. Next place one of the patterns over a sheet of semiglossy paper and, with a wax paper sheet between, trace over the lines of your pattern with the smooth, blunt end of a penholder. The pressure will cause invisible lines of wax to be transferred to the blank news sheet beneath. Proceed in a like manner with the remaining patterns and your musical cartoons will be completed.

The prepared sheets are then assembled in tablet fashion so that each one can be removed, or folded over the back of the board, on completion.

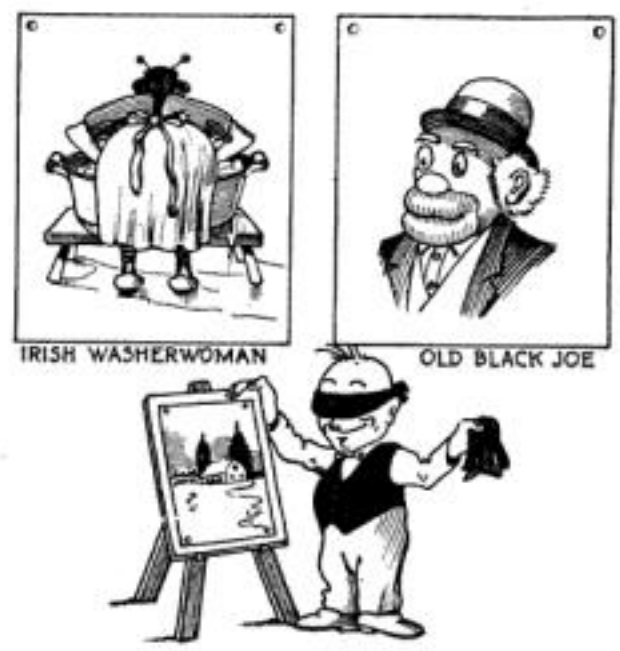
Arrange now with some pianist to act as your confederate, ask her to take her place in the audience as one of the spectators. Give her a list of song numbers for which you have prepared illustrations and request that she memorize them.

YOU are then ready to begin your program.

As the curtain rises to disclose your stage arrangement you address the audience somewhat in this manner:

"Ladies and gentlemen, I am about to reveal to you one of the most mysterious and science-defying powers of music—the transmission of pictures by the medium of sound waves. We are told that sound waves have been photographed, but never before have they been made to produce illustrations of the sentiment expressed, as they will do here.

"Standing before this board, in the full view of everyone, I will cause pictures to appear before your very eyes; pictures made from the sound waves of any selection that may be played upon the piano. I will employ no crayons, no pencil—nothing but this simple cloth which I will pass over the surface of the paper in order to fix the waves as they strike the sketch board. There will be no hidden movements of any kind, no covering of the sketch board, and yet an illustration in harmony with the melody played will instantly appear as soon as the strains of music begin.



Three suggestions for cartoons. They should be sketched in a vigorous, humorous manner.

"Now, I am going to need the assistance of a pianist in this work and, to show you that there is nothing up my sleeve, I will ask some lady in the audience to kindly volunteer. She may play merely the chorus of any selection she desires. I request, however, for the benefit of the audience, that she restrict her selections to numbers that are familiar to everyone. These may be new or old, according to her choice."

Your confederate should not immediately spring to her feet and rush to the piano, but should allow sufficient time to elapse to avoid raising any suspicion of prearrangement. It is very difficult to procure a voluntary assistant for a program of this kind, as the very nature of the stunt suggests a "trick," and no one will be very anxious to respond for fear of being made to appear ridiculous.

When your assistant finally presents herself, thank her for her kindness and request her to seat herself at the piano and to concentrate seriously upon the songs she plays. Warn your audience that strict silence must prevail to avoid confusion of the sound waves and resulting damage to the picture; then signal the pianist to begin playing the first selection.

As the strains of music commence, wave the prepared cloth back and forth before the sketch board with an air of mystery, finally rubbing the cloth upon and over the surface of the topmost sheet of paper. The graphite in the cloth will adhere to the paper over the lines of wax and the picture will gradually take form.

The Men Who Will Award Our $10,000 Prize

(Continued from page 43)

probably the most famous automotive engineer in the world. It is estimated that he passes judgment on an average of 350 new inventions each week. The thousand-acre proving station near Detroit, where every automobile and automobile part produced by or offered to General Motors is tested, was constructed under his direction, and the severe practical road tests to which all cars are submitted were devised by him. He is also the inventor of the electrical devices which illuminate the dial, ring a bell, and print a slip every time a sale is rung up on a cash register, and of the Delco portable farm lighting system.

DR. ARTHUR DEHON LITTLE, one of this country's most distinguished chemical engineers, has worked out more processes of paper manufacture than any other chemist in the world. Not long ago, he developed a practical method for making newsprint paper from Southern woods, which promises an enormous reduction in the cost of newsprint when operated on a large scale. Processes for the manufacture of vegetable glue from starch, the recovery of turpentine and resin from yellow pine stumps, and the extraction of zinc from complex ores are among Dr. Little's other impressive accomplishments of the last few years. In addition, he is the inventor of processes for the manufacture of chrome-tanned leather and artificial silk, and has directed the production of a long line of alcohols and special products from petroleum. Dr. Little is president of the Society of Chemical Industry of Great Britain and past president of the American Chemical Society and the American Institute of Chemical Engineers. He holds the honorary degree of Doctor of Chemistry from the University of Pittsburgh.

DR. JOHN CAMPBELL MERRIAM. As president of the Carnegie Institution at Washington, D. C., Dr. Merriam, since 1920, has directed the manifold and world wide scientific activities of this great organization of research and discovery, which comprises departments of Botanical Research, Experimental Evolution, Economics and Sociology, Geophysical Laboratory, Marine Biology, Meridian Astrometry, Historical Research, Mt. Wilson Solar Observatory, Nutrition Laboratory, and Terrestrial Magnetism. Dr. Merriam is known for his work as a paleontologist, an administrator, an educator, and an author. As a paleontologist, he has distinguished himself by his discoveries and studies in the field of early forms of human and vertebrate animal life on the American continent, particularly in California, where he unearthed from prehistoric tar pits the fossilized remains of men and ancient animals.

DR. ROBERT ANDREWS MILLIKAN. Awarded the Nobel Prize in Physics in 1923 for isolating the electron and measuring its charge in his famous "oil-drop" experiment, Dr. Millikan, one of the foremost of living physicists, is even better known for his research work in cosmic rays. In 1925 he ascended Mt. Whitney, in southern California, in search of a high, clear atmosphere in which to measure the extraordinary penetrating power of these short, invisible rays which bombard the earth from all directions. After repeating the experiment in Panama and Bolivia, he announced that cosmic rays originated in the outer spaces, long supposed to have been empty, between the stars. He demonstrated that these rays probably are the by-product of the birth of complex atoms, such as helium, silicon, and iron, out of simpler atoms such as hydrogen, and that the universe, hitherto believed to be deteriorating, is constantly being renewed.

Dr. Millikan is chairman of the Executive Council of the California (Continued on page 142)

The Men Who Will Award Our $10,000 Prize

(*Continued from page 141*)

Institute of Technology. He holds honorary degrees from numerous American and foreign universities.

PROF. HENRY FAIRFIELD OSBORN is president of the American Museum of Natural History, New York, which, in the twenty-two years of his administration, has developed into one of the greatest institutions of its kind in the world. His conception of a museum is a vast theater where people in all walks of life may view the great pageant of human and animal existence as far back as it can be traced. Before 1908, Prof. Osborn was curator of the Department of Vertebrate Paleontology. In that capacity, he assembled in the Museum the most extensive collection of vertebrate fossils extant. Many of them resulted from annual expeditions under the Museum's auspices, all of which he planned and many of which he accompanied. From 1891 until 1910, he was a member of the faculty of Columbia University. Since 1910, when he retired from active teaching, he has been research professor of zoology. He is the author of numerous scientific monographs, the holder of many academic honors, and a member of a large number of learned societies.

DR. ELMER AMBROSE SPERRY, chairman of the Board of Directors of the Sperry Gyroscope Company, Brooklyn, N. Y., is considered by many authorities second only to Edison as an inventor. His reputation in the scientific world is based principally upon the Sperry searchlight, which illuminates objects more brightly than sunlight; the gyrocompass, and the gyrosteerer, and the gyrostabilizer for ships. The three last are used by every navy and merchant fleet in the world. He also is the inventor of the Sperry aerial torpedo and many other implements of war. In all, he holds about 400 patents issued in the United States and Europe, among them the Sperry carbide light; patents on electric street cars capable of climbing steep grades; electric coal mining machinery; and electrochemical processes for making caustic soda and chlorine salt. In recognition of his inventive genius, medals, awards, and other distinctions have been showered upon Dr. Sperry. He is one of the founders of the American Institute of Electrical Engineers and of the Electrochemical Society, and a member of several learned societies.

DR. SAMUEL WESLEY STRATTON, president of the Massachusetts Institute of Technology, Cambridge, Mass., since 1923, and director of the United States Bureau of Standards for twenty-two years before that, is noted for his work as a physicist and as an educator. He is former secretary of the National Advisory Committee for Aeronautics, a member of the National Research Council, the International Committee on Weights and Measures, the American Institute of Electrical Engineers, the American Philosophical Society, the National Academy of Sciences. For his work in physics, Dr. Stratton has been awarded the Elliott Cresson Medal by the Franklin Institute, and the National Academy of Sciences has bestowed its public welfare medal upon him. He holds honorary degrees from Yale University, Harvard, and the Rensselaer Polytechnic Institute.

DR. ELIHU THOMSON. Modern industry is indebted to Dr. Thomson for the invention of electric welding. He is the holder of nearly 800 patents for electrical devices, the most important of which are a three-coil armature for dynamos and motors, an induction motor, electric meters for direct and alternating currents, and magnetic blow-outs for switches and fuses. His contribution (*Continued on page 148*)

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(Continued from page 142)

to present-day illumination is a constant current regulator for arc lighting dynamos—the device which took the flicker out of arc lamps. His career as an inventor and manufacturer began in the late '70's when, with E. J. Houston, he was engaged in experimenting with electric dynamos.

Dr. Thomson is the director of the Thomson Laboratory of the General Electric Company, at Lynn, Mass. He holds honorary degrees from five great American and English universities and has been the recipient of numerous awards and distinctions, including an officership in the Legion of Honor.

DR. EDWARD RAY WEIDLEIN, director of the Mellon Institute of Industrial Research, at Pittsburgh, Pa., has won a commanding position in the scientific world through his brilliant work in the production and assay of ores, especially copper, by wet processes, and his original researches in several other fields. One of this country's leading chemical engineers, he served as chemical expert on the War Industries Board and as chairman of the fuel committee of the National Research Council in 1918 and 1919. Dr. Weidlein first attracted attention by his research work on camphor and on ductless glands. He is a past president of the American Institute of Chemical Engineers, a member of the American Institute of Mining and Metallurgical Engineers, the American Chemical Society, the National Education Association, the American Electro-Chemical Society, the Franklin Institute, the American Academy of Political and Social Sciences. Tufts College conferred the honorary degree of Doctor of Science upon him in 1924.

HENRY HERMAN WESTINGHOUSE, a director of the Westinghouse Electric and Manufacturing Company, is a distinguished engineering executive. Like his brother, the late George Westinghouse, inventor of the railway air brake, he began his apprenticeship to the machinist trade in his father's shops in Schenectady, N. Y., and later studied mechanical engineering at Cornell University. Since 1873, he has been connected continuously with the Westinghouse Air Brake Company, of which he is Chairman of the Board of Directors. He is also Chairman of the Board of Directors of the Canadian Westinghouse Co., Ltd., and of the Westinghouse Brake and Saxby Signal Co., Ltd., of London, England, and president of the Compagnie des Freins Westinghouse, of Paris, France. He is a trustee of Cornell University.

DR. ALBERT EASTON WHITE, director of the Department of Engineering Research of the University of Michigan since 1920, is noted as a metallurgical engineer, ordnance expert, and educator. During the war, as a Captain and later as a Major in the United States Army, he headed the metallurgical branch of the Inspection Division of the Ordnance Department. At the close of the war, he became head of the metallurgical branch of the Technical Staff, and now holds the rank of Lieutenant Colonel in the Ordnance Reserve Corps. Dr. White has served as consulting engineer with the Detroit Edison Company, the Packard Motor Car Company, and other industrial concerns. He is a member of the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, the American Society for Steel Treating, of which he is a former president, and other organizations. He holds the degree of Doctor of Science from Brown University.

DR. WILLIS RODNEY WHITNEY, a chemist by education and training, is known most widely for his work in electricity, principally as the director of research (Continued on page 144)

The Men Who Will Award Our $10,000 Prize

(*Continued from page 145*)

of the General Electric Company, at Schenectady, N. Y. One of his most important inventions was a submarine detector, used during the World War. As early as 1923 he demonstrated, on a laboratory scale, the transmission of "power by radio." Recently, he exhibited a new device that may bring such transmission on a commercial scale a step nearer—the short-wave, high-power ZT-6 radio tube, which radiated sufficient power through the atmosphere of a room to light lamps without wires. He is working now on a "talking book," using talking motion picture apparatus to record, without pictures, the entire content of a full-length novel. He holds honorary degrees from four Universities and is a member of numerous learned societies.

ORVILLE WRIGHT, the first man to fly in a power-driven, heavier-than-air machine—December 17, 1903—is world famous as the co-inventor of the airplane. For his accomplishments in the field of aeronautics, Mr. Wright has been awarded the Collier Trophy and has received honorary degrees from several American and foreign universities and gold medals from more than a dozen organizations such as the Aero Club of France, Aero Club of the United Kingdom, Aero Club of America, the Smithsonian Institution, the Franklin Institute, and the French Academy of Sciences. The Congress of the United States conferred a special medal upon him, as did the city of Dayton, O., where Mr. Wright was born. He was awarded the Cross of Chevalier of the Legion of Honor by France in 1909, and the Cross of Officer of the Legion of Honor in 1924.

Mr. Wright is a member of the National Advisory Committee for Aeronautics and chairman of the advisory committee of the Daniel Guggenheim School of Aeronautics, New York University.

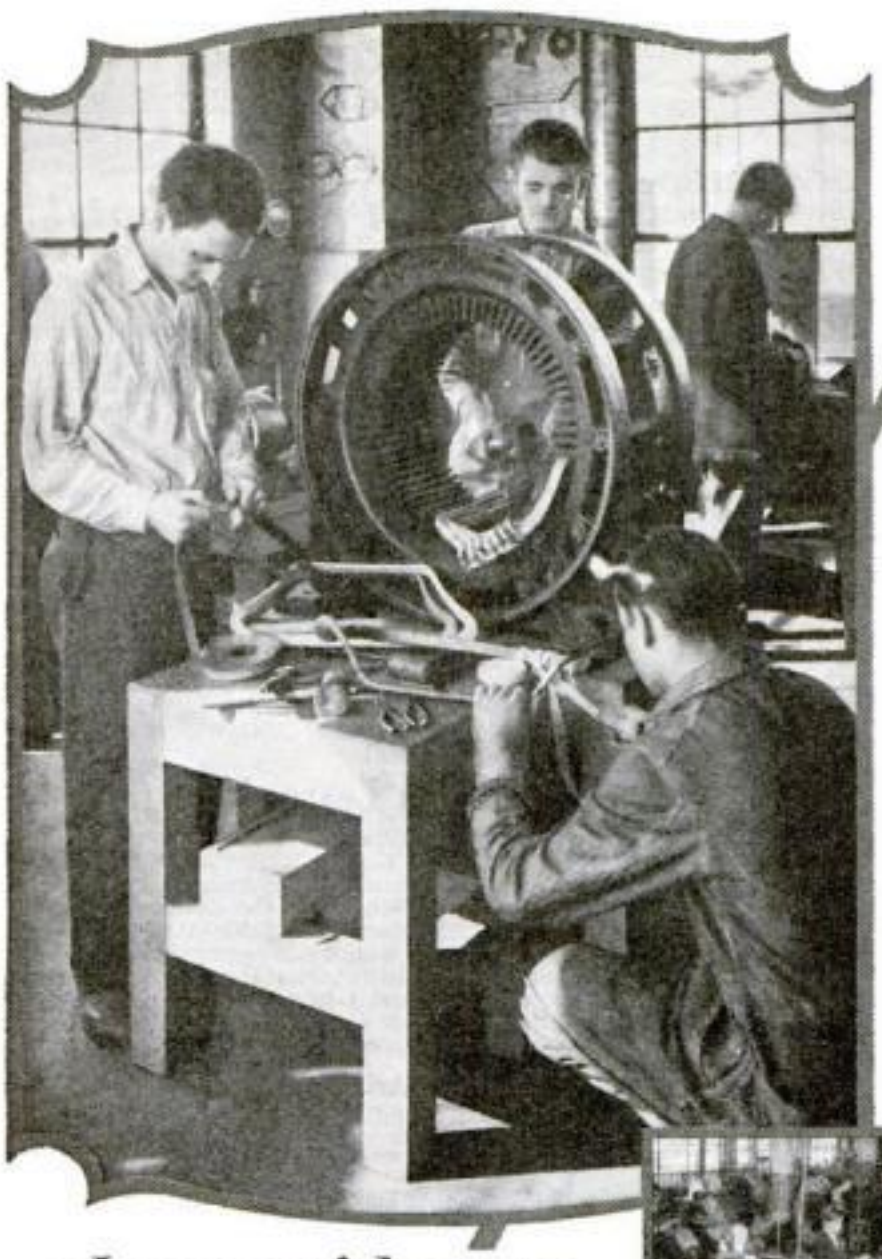
Was Your Dog Once a Wolf?

(*Continued from page 57*)

dog family. From this ancestral type, he concludes, certain dog breeds deviated and became freaks because of the disturbance of their endocrine or ductless glands—especially the thyroid and pituitary.

Thus the popeyes of the Boston terrier would be a symptom of goiter or thyroid trouble. The Pekinese and Pomeranian dog, counterparts of human dwarfs, would be the result of thyroid and pituitary trouble. The St. Bernard, according to Dr. Stockard's theory, would have acromegaly, a bony overgrowth disease due to pituitary trouble; and the Great Dane would be the product of a sort of gigantism that corresponds to a rare human disease due to endocrine trouble. If Dr. Stockard's explanation is correct, treatment with certain gland extracts should make bulldogs lose all their prize-winning points and grow up to be police dogs. Should such a procedure become regular practice, what may not be predicted for the dog shows of the future? The winning of a blue ribbon will be an arbitrary affair.

Most recent evidence for the contention that all breeds of dogs were born from one common stock is afforded by the brilliant work of S. Harmsted Chubb, Associate Curator of Comparative Anatomy at the American Museum of Natural History. Testing a theory that all dogs run in the same way, he took action photographs of two in particular widely diverse in breed—the Irish wolfhound and the English bulldog. He found that, when they run, both dogs pass their hind legs outside their front ones, a difficult feat for the bulldog with its broad shoulders. But the deep-seated ancestral habit crops out in spite of all man may do to alter the type by breeding.



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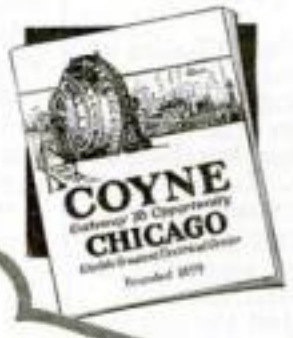

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Why Tire Chains Are Safest

(Continued from page 74)

with a team of horses to pull him out. If he'd had chains along he'd have saved at least twice what they cost him."

"H'm," grunted Morrison, "I hadn't looked at it just that way. The darn things are so noisy and wear out so quick I kind of hate to bother with them."

"You can keep down the noise," said Gus, "by using the spring tighteners, but you don't want to get them so tight they don't move on the tires, or they'll cut through the tread in no time. As for wearing out, it's a good hunch to put 'em on the other side out every time you apply 'em. You can get double the wear that way, because when you turn 'em over the wear comes at a different point on the link."

"WELL," Morrison said as he climbed into his car, "I suppose now you'll try to sell me another pair to put on the front wheels."

Gus laughed. "No, I hardly think chains on the front wheels are worth while these days, when the tires are so large, though it depends a lot on the car. I saw a dumbbell the other day driving one of these new front-drive cars and he had the chains on the rear wheels. That would be just as foolish as for you to put chains on the front wheels and leave the rear wheels bare."

"What would you have done if you hadn't any chains that fitted my car?" Morrison asked.

"I'd have hooked on the service wagon and pulled you out," said Gus. "That's the easiest way. I only used the chains to convince you they were good dope. There are lots of ways to get a car out of a mudhole. The main thing is to remember that the two wheels can turn independently, so there's no use in doing anything to the wheel that is stuck in the mud unless the other wheel is on dry ground. If both of 'em are stuck, then whatever you do to one wheel has to be done to the other wheel, too. Sometimes you can get out of a mudhole by putting the brakes on a bit. That only works if the brake on the side that's stuck holds a little tighter than the one on the pavement."

"WHY wouldn't it be a good idea just to carry some pieces of rope in the car and wrap 'em around the tires when you get stuck?" Morrison asked.

"That would work all right in mud or deep snow," Gus replied, "but it wouldn't be much good on ice. Nothing is any good on ice unless it'll cut in the way chains do. Of course, if you're going to do a lot of touring in a country where you are likely to get stuck in mud up to the hub caps every so often, it's a mighty good plan to take along enough rope to give you a chance to use a block and tackle. If all four wheels get bogged in real soggy mud the easiest way to get the car out is to hook up a block and tackle to the frame, with the other end lashed to a tree or a stake driven into the ground, and just haul away until you pull the car through."

"Thank goodness, I don't have to do any touring like that," said Morrison. "Put on the other chain and stick the pair on my bill."

Helium Plant on Wheels

HELIUM gas passes through nearly half a mile of copper tubing to be purified, in a mobile reclaiming plant developed for the Navy's new airships under construction at Akron, O. The outfit can be towed behind a motor truck. Previously, gas-reclaiming plants were so heavy that they had to be mounted on railroad cars for transport. The new plant can meet an airship at the point of landing and restore its air-contaminated lifting gas to the standard purity of ninety-eight percent.

Beating the Weather in the Air

(Continued from page 60)

forward the stick. We dove three hundred feet before he could pull himself back in place.

A good flyer can "feel a bump coming" and can ease the after drop. A poor flyer often makes jolts for himself by overadjustment. In passing through a rising current, the "air-blind" flyer keeps the nose of his ship pointed too far down. When he leaves the rising air the ship drops a few feet before he can pull his nose up.

AFTER several hundred hours of flying a pilot learns where to look for bumps. As a rule, the air is bumpiest over cities and hilly country. On hot days, every time you fly over a concrete highway or a railroad track, you are lifted and dropped. In passing out of the sunshine into the shadow of a cloud or in flying over a river or small lake, the ship makes a drop. However, in crossing a large lake the air is usually smooth.

Sometimes in flying low above a factory with high smokestacks belching hot gases, you get a jolt. In fact, a chimney illustrates how bumps are formed. Columns of heated air rise from the ground while cooler currents move downward around them. Differences in the amount of heat radiated from the ground accounts for the rising and falling air currents. Grazing lands and pastures, for instance, get hotter than fields of growing corn. Plowed ground heats up quicker than a grain field. A sandy beach gets hotter than the adjacent water and cultivated fields throw up more heat than woods or marshes. A typical example of a "permanent bump" in the air lies over the sand dunes that border the southern end of Lake Michigan on the Cleveland-Chicago air mail route. There is cool air descending over the water, heated air rising above the dunes, and cool air dropping above a belt of swamps to the south of the dunes. In flying over this stretch, a ship first is dropped, then tossed upward, then dropped again

ORDINARILY, a plane, meeting a bump, rises and drops only a few feet. But under abnormal weather conditions ships have been reported to plunge more than 1,000 feet in a down draft. The air over mountainous country usually has more severe bumps than that above level stretches. However, the bumpiest flight I ever made was between St. Louis, Mo., and Columbus, Ohio, mostly over level land. It was a scorching day. The air boiled all the way, and for three hours the ship flopped and jumped about like a fish on land.

But my most memorable experience with an air current was a battle with a giant settle-draft above a wild ravine in the Balkan Mountains. I was flying air mail between Sofia, Bulgaria, and the Black Sea. It was a 350-mile trip and crossed mountains 10,000 feet high. I was using a French ship, a Nieuport with a 120-horsepower LeRhone motor. A strong head wind was blowing as I approached the first of the mountains. A wind tends to follow the contour of a hill. On the windward side it ascends; on the lee side it descends. Flying in from the sheltered side, I pulled back the stick and opened up the motor. Just as the Nieuport began to climb, it was caught in the violent settle-draft pouring down the mountain side. The bottom dropped out of the air. The ground leaped upward. The motor shrieked. The air speed indicator hand swung ahead. At such a speed we should have been climbing at the rate of more than 800 feet a minute. Yet the ship actually was falling toward the trees and a rock-strewn ravine below. My only chance was to slap on full gun and climb. A slower ship couldn't have made it. For more than a minute the engine raced with every ounce of power. Foot by foot, it pulled us away *(Continued on page 149)*

Beating the Weather in the Air

(Continued from page 148)

from the tree tops. At 900 feet, I was above the down current and safe.

A few months ago, I tried out a new supersensitive altimeter for an inventor. On the take-off run, the hand of the instrument indicated the plane was fifty feet in the air before the wheels left the ground. The partial vacuum, caused by the air rushing past the cockpit, reduced the air pressure within sufficiently to affect the instrument.

In a strong wind, a similar partial vacuum exists on the lee side of every large building. In taking off at an air field, the pilot should head between the hangars instead of passing low over them. If he tries to skim just above the building on the take-off, his machine is likely to drop into the "dead air" and crash into the side of the hangar.

NEAR the ground, winds are usually stronger in the afternoon than in the morning. High in the air the opposite is true. It has been found also that the upper winds over North America tend to veer to the west. Among the mountains, on otherwise calm days, breezes move upward out of the valleys during the day and down into the valleys at night. This results from the heating and cooling of the ground in the depressions.

One valley has become famous as a door that lets air mail flyers through the Allegheny Mountains in bad weather. It is the Woodward Pass. When clouds hang so low they obscure the mountain tops, the pilots take to the pass. The ships wind along the narrow channel under the cloud ceiling as though they were flying through a tunnel. They suggest fish swimming up a river under the ice. The flyers know every turn and narrow place. They could fly through with their eyes shut. Some of them even use the pass at night.

Of all weather conditions, low clouds and fog are among the most dangerous. A pilot who takes his ship into fog is blinded. The ground and all landmarks disappear. It is like turning a corner in an automobile and being blinded by approaching headlights. Only in a plane you can't slow down as you can in an auto. You have to keep going at express-train speed. Otherwise, you stall and crash.

One morning I took off at Curtiss Field, N. Y., in a low fog to observe conditions at a practice field a few miles away. Instead of lifting, the fog began closing in. Everything turned as gray as an oyster. I headed for home, hedge-hopping along, sometimes lower than the telephone poles. The fog had become as thick as soup when I saw a plowed field below. With one wing dragging, I circled and pancaked down a dozen yards from a boundary fence.

WHEN fog is so thick that a pilot can see less than an eighth of a mile, the weather report gives "no visibility." When he can see five miles or more, the report is "good visibility." Along the model airway established in California with the help of the Guggenheim Fund for the Promotion of Aeronautics, visibility conditions ahead are signaled by ground signs to the pilots as they pass over intermediate fields. White canvas strips, each three feet by fifteen feet long and laid flat on the ground, are used to form the signs. To indicate that the "ceiling," or height of the clouds, is more than 2,000 feet, the strips are formed in the shape of a U. For overcast ceiling, but above 1,000 feet, the signal is a dash. For "come down, detailed reports," it's a cross.

In flying toward a large city, a pilot often sees, from a distance, a cap of haze hanging over it. This cap is formed by dust and smoke particles in the air. When tiny droplets of moisture condense upon such particles, fog is formed. A new

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Beating the Weather in the Air

(Continued from page 149)

flying term, recently coined, is "smog." It means smoke-laden fog, one of the densest a flyer meets.

In a fog or cloud the turn and bank indicator is the most valuable instrument on a ship. Without it a pilot might turn or side-slip without realizing it. If he depended upon his senses entirely, he might get into a tight spiral and end in a spin, knowing that something was wrong but not exactly what. The air tubes connected to these instruments are now placed closer to the motor than they used to be. Its heat keeps them thawed out when they might otherwise become clogged with snow or ice.

TO TRAIN my sense of balance I used to practice climbing through clouds without looking at my instruments. Often I would get almost to the top, then lose my balance and come out in a steep dive or a side slip. During the war, pilots had to be careful about coming out of clouds that way. Once I tumbled out right into the midst of three enemy planes. I scuttled back for the cloud. We played hide and seek until they set out after bigger game.

Before a long cross-country trip, you should prepare for bad weather emergencies. Familiarize yourself with the best landing fields along the way in case the ship is forced down. Make out a time-table showing when your should arrive at different points along the route so you can check your ground speed. Your air speed indicator shows your speed through the air only. A head wind cuts down your speed over the ground and a tail wind increases it.

On my last trip to Cleveland, I almost sat down in Lake Erie. It was "bird-walking weather," which is the flyer's term for the worst kind of air conditions. (Even the birds have to walk.) As I neared the city, visibility got so bad I was almost scraping the tree tops. Then the rain began to pour. I was in a cabin ship. The water streamed down the windows so I could see almost nothing outside. Then the compass went "haywire." I climbed and headed in the direction in which I thought the airport lay. The downpour began leaking into the cabin. I saw it trickling over the instrument board. If the water reached electrical connections, the engine would cut out. I threw my hat over the switch to protect it.

THE rain decreased a little. I dropped down where I thought the airport must be. Underneath was nothing but tossing waves. I was somewhere over Lake Erie. Just before the rain had begun, I had noted that the ground wind was from the west. I could see the waves pitted by raindrops driven from what must be the west, unless the wind direction had changed. I figured I must have swung north in the fog. I took a chance and banked to the left. Five minutes later, a white line appeared ahead—shore breakers. I crossed the airport twice in the foggy drizzle before I was sure I had arrived. I could hardly see when I set the ship down. Crash! She bounced a mile in the air. But I didn't care. I was too glad to be down on solid ground.

That experience took place in autumn. At that time of year, rainstorms last longer and fog is thicker. But both occur less frequently than in summer. Ordinarily, a pilot is not forced down by rain. Many rainstorms are local. They can be flown through in less than half an hour. In an open cockpit ship, I have found it a good plan to have a rag handy to wipe off my goggles in a rain. Sometimes, however, you can see better in a hard downpour if you let the water stream down the glasses instead of trying to wipe it off. In heavy rains, I have had to take off my goggles, crouch down behind the windshield, and fly by the instruments until the deluge lessened.

Even worse than (Continued on page 161)

Beating the Weather in the Air

(Continued from page 150)

rain, for visibility, is snow. In flying through a snowstorm, you can hardly tell which way is up. Everything becomes a thick, grayish-white swirl, streaking and slithering past the cockpit. The only direction in which a pilot can see with any clearness is straight down. And when the ground is covered with snow, it is easy to misjudge distance. There are few contrasts in color. Snow also hides bumps and holes and makes a forced landing in an open field hazardous.

On a snow-covered field, I once had a curious accident. The snow was soft. On the take-off run, the propeller kicked it up in chunks. Just as I eased back the stick and climbed into the air, the motor gasped and stopped dead. We sat down with a jolt. I found a mass of snow had been thrown into the air intake, choking off the engine.

WHILE fog is called the airman's greatest enemy, sleet in some ways is more menacing. You can keep flying in a fog as long as the gas holds out. But sleet weighs down the plane and alters the curve of the lifting surfaces. The ship is no longer able to fly. The bracing wires, coated with ice, double in size, increasing resistance. The propeller, irregularly coated with sleet, sets up dangerous vibrations. As soon as the sleet begins to accumulate, a flyer should drop to lower and warmer altitudes where the sleet may melt. On the average, the temperature rises one degree for every 300 feet a plane descends. It is ten degrees warmer at the earth's surface than it is 3,000 feet in the air. If the sleet fails to melt at low altitudes, a landing is imperative while the plane is still under control.

I WAS once up in a ship with a creeping throttle. The lever controlling the speed of the motor would work ahead if there were any undue vibration on the plane. I was flying a couple of thousand feet above the Hudson River, on my way to Albany. Near Poughkeepsie, a March drizzle set in. Then the weather changed to bitter cold. An icy wind swept down the river, freezing the rain to sleet. The wings became a glare of ice. They groaned and cracked at every gust. Ice formed on the whirling propeller. Chunks broke off and flew into space. The vibration from the unbalanced blades shook the plane. I jerked back the throttle for a glide to lower altitudes. My goggles had become partly covered with sleet. On the way down I tried to take them off. As soon as I removed my hand from the throttle to unsnap the helmet loops holding the goggles in place, the vibration from the propeller quickly pulled open the creeping throttle. The motor thundered. The machine shook like a tree in a storm. I was afraid the engine would be torn from its mountings. I didn't dare let go the throttle again until all the ice had melted from the "prop."

In my sixteen years on the highways of the sky, I have met all kinds of weather. No two days are alike. Air conditions alter from hour to hour. Nowadays, planes take off under threatening skies that used to drive them into their hangars. They head into howling gales. Aviation is out of the fair-weather stage. So, more than ever before, a pilot needs to know his flying weather.

Air Line Flag Stations

FLAG stops for airplanes, like flag stations for railroad trains, have been added by a transcontinental air line, extending its scheduled service. Three such stops are at Vandalia, O.; St. Elmo, Ind.; and Terre Haute, Ind. At these points passengers may board planes by notifying the company's representative, and passing planes stop for them on signal.

How Pygmy Tugboats Dock a Giant Liner

(Continued from page 23)

from the propellers. The three boats beside us have gone into action. At the bow of the liner on our side, two additional tugs strain backward on hawsers trying to drag the bow in toward the slip. They suggest a pair of puppies flattened out pulling ropes with their teeth. On the other side of the stern another pair of tugs are churning the water white as they struggle at the ends of heavy lines, pulling the stern around into the tide.

The *Leviathan's* four propellers begin turning, the ones on our side in reverse, those on the other side ahead. This has the effect of twisting the liner in toward the slip, helping the tugs. The rush of water along the side of the vessel, from the reversed propellers, forces the tug nearest the stern to slide along the side of the ship, crowding it against the *Dalzellea*.

THE water churned up by the liner's propellers is roily, mud-filled. Near Pier 86, the river is only about fifty feet deep at low tide. The draft of the *Leviathan* is more than forty. Thus, with little room for water to pass under the keel, the effect of swinging the huge liner broadside to the current, even a slight current, is like forcing a dam, forty feet deep and more than 900 feet long, upstream. Against this mountain of water, the eight tugs pit their strength. In winter, with ice piling against the upstream side, the difficulty of the maneuver is increased many fold.

Looking on from the outside, such a struggle seems hopeless. It is when you see the powerful engines that fill the tug's hull, learn that the propeller on each tug is almost two thirds the size of one on the *Leviathan*, note the terrific drive of the little boats—sometimes they break four- and five-inch ropes—that you perceive in these awkward craft a strength fit for the battle.

Tugs have been described as being "all muscle." The description is correct. The engines of the *Dalzellea* develop between 850 and 1,000 horsepower. Sitting low in the water, its propeller ten feet below the surface, the little vessel has the forward drive of a sprinter getting out of starting holes. In still water, this 100-foot, 180-ton tug can drag a 10,000-ton steamer at six miles an hour.

HOWEVER, minutes pass while the tugs apparently churn the water in vain. Then the tip of a pier some distance up the river begins to creep slowly toward the liner. The bow of the *Leviathan* is swinging in. The propellers on the big ship stop. The two "puppies" ahead cease straining at the hawsers, begin pushing against the side of the bow, holding it against the tide as the great boat turns more and more broadside to the stream. A small tug runs a twelve-inch rope, thick as a small tree trunk, to the pier. It is connected to a windlass on the liner to help pull the bow in toward the slip. A second rope of the same size follows. As the ship moves into the slip, these ropes are "walked along," moved from one pier mooring to another as the vessel progresses.

There have been cases when even huge, foot-thick cables such as these have snapped like threads. The breaking of four- and five-inch ropes is a frequent occurrence in the life of a tugboat. Sometimes when two tugs are pulling in tandem, the cable parts.

"What happens?" I wanted to know.

"Oh, nothing much. The boats give a great exhibition of plowing up the water, but they don't go far. They back up, take on another line, and begin again."

It was under such conditions, several months ago, I learned, that the quick wit of Captain Charles Coon of the "*Grace A. Barrett*," saved $200,000 in the space of a minute. While his tug was pulling the bow of a liner up against the tide, while approaching (Continued on page 153)

How Pygmy Tugboats Dock a Giant Liner

(Continued from page 152)

a Brooklyn slip, the rope parted. Drifting with the current, the liner headed for a double string of railroad barges that had been "hung up" at the next pier. The great vessel's momentum would have been sufficient to slice its knifelike prow through the barges and the freight cars they contained. There was no time for Coon to take on a new line or even to turn around. In the emergency, he did the only thing possible. He shot crayfish-wise against the bow, shoving backward in full reverse. The action deflected the course of the ship so it slid past the barges with only a glancing blow. Besides being a gamble with the unexpected, docking ocean liners is a battle of wits involving high stakes. A single dented plate on a big ship may mean a loss, counting repairs, demurrage, and wasted time, of as much as $80,000.

With the *Leviathan's* nose poked inside the slip, the two tugs at the bow ease their pushing. Protected by the upstream pier, the effect of the tide is diminished within the slip. From now on, the work of the tugs is easier.

A SINGLE whistle from the bridge. McLaughlin raises one arm. The tugs around us slow down to half speed. The harbor pilot leans over the rail, motioning inward to the two forward tugs. The bow has swung too far out. They fume and puff, shoving it slowly back to the "camels." When at last the big ship touches all the "camels" and is made fast to the pier, the docking is completed.

In winter, even after the vessel is inside the slip, the troubles of the tugboats are not over. Floating ice piles up between the pier and the ship, holding it out so far that the gangplanks will not reach. Then, two or three tugs have to churn back and forth, breaking up the ice and kicking it out with their propellers. Others, attached to hawsers, keep the liner away; for, one squeeze between the sea giant and the pier would crush a tug like an empty eggshell, even though these small boats are probably the toughest of their size afloat. In heavy seas, with loaded barges lashed to each side, their groaning timbers withstand the nutcrackerlike crushings of the barges that come in from opposite sides at the same moment.

In Baltimore, one tug has withstood the daily pounding of active service for sixty-five years. Of the 700 tugs in New York Harbor, many are fifteen or twenty years old. No one can ride on these stout fellows of the water for long without a growing admiration for their sturdy power and tremendous capacity for taking punishment. At first they seem the ugly ducklings of the harbor. Their squat, bulging bodies, their pilot houses perched high above the deck like small heads on huge bodies, their mats of rope at the bow looking like mouthfuls of seaweed, give them a ludicrous appearance. On board, this unfavorable impression is soon lost in an appreciation of their virtues.

INCIDENTALLY, there is a good reason for placing the pilot house some twenty feet above the water line. In rough weather, the galley and the engine room are closed so that waves breaking over the deck do no harm. Under such conditions, the tug weathers severe gales, plowing through the water almost like a submarine running at the surface. Once, Captain Howell was caught in a storm on Long Island Sound in which the wind blew sixty-five miles an hour. Before he reached port, a giant wave had crashed against the pilot house, breaking a window.

But storm or shine, day or night, winter or summer, the docking of ocean liners goes on. If conditions are bad, more tugs are called. Only fog can stop them. One week, last December, more than 100 ships were held off Sandy Hook, unable to dock because of fog. When the weather (Continued on page 154)

How Pygmy Tugboats Dock a Giant Liner

(Continued from page 158)

cleared, a procession of fifty big vessels moved up the Bay and for twenty-four hours the tugs worked at top speed. The *Dalzellea* helped bring in fifteen in one day. The usual number is three or four.

It was in thick weather off the lower tip of Manhattan that Captain Howell had one of his few accidents—a mishap that had its humorous side. He was helping haul a barge, loaded with more than two hundred sheep, across the bay when a vessel loomed up out of the mist and rammed the barge. It filled rapidly with water. In the emergency, Howell ran it alongside the pier at Governor's Island, an Army base, and obtained permission to land the sheep. The commanding officer ordered all the soldiers out to join hands and form a living fence to corral the animals and keep them from overrunning the island. This maneuver would have been successful but for a frightened lamb. It made a dive between the legs of a big buck private and the two hundred sheep stampeded after it, tripping up the soldiers, knocking them down, and running over them in the mad rush.

"ALL you would need to win a war," Captain Howell says, "is a couple of million sheep!"

It was a few minutes after twelve o'clock, noon, when the *Dalzellea* had first reached the high steel side of the *Leviathan* in midstream. It was nearly one when we heard McLaughlin's final whistle and saw him waving us away. It had taken more than forty minutes to move the ship three times its length and make it fast. A record, made under ideal conditions during the war, is four and a half minutes.

Down the flank of the *Leviathan*, from the bow, one of the "puppies" comes nosing along. Reaching the four tugs at the stern, it slices between their bows and the side of the ship, turning them out toward the river. They jostle and bump together, then separate and puff off downstream—the *Dalzellea* to bring in a huge oil tanker, the others to go about various tasks. For putting America's biggest liner to bed is only an incident in the day's work of these tide-fighting, wind-fighting, ice-fighting craft of the harbor.

Thousands Are Flying Gliders

(Continued from page 21)

ing point; speed, returning to point of departure over a distance greater than one mile; landing on a mark.

The skill with which machines can be brought down in "on the mark" landings was demonstrated during the Detroit meet. In a 28-mile-an-hour wind, five machines cut loose from towing planes at 2,000 feet and, one after the other, came down in spot landings. None of the five machines came to rest more than forty feet from the flag. Recently, a German student made a spot landing that was *too* accurate. Below him, he saw men putting up haycocks. He decided to show his skill by "sitting down" exactly on top of one of the piles near the edge of the field. He made the landing all right, but the mound he had chosen proved to be a pile of rocks. It "took his machine to pieces"—the gliding term for a crash—but left him uninjured.

There are 300,000 members in the Airplane Model League of America. It is estimated that within the next few years half of this number will "graduate" into glider flying. New recruits are added daily to the army of those interested in the sport. The coming months will be the busiest in glider history, and new American records will be the aim of the hundreds who will take to the air in motorless ships of the sky.

Here Are Correct Answers to Questions on Page 48

In the files of our Information Department are thousands of questions asked by our readers, from which these monthly questions and answers are compiled. What particular field or fields of applied science would you like to have presented in this form in forthcoming issues? Your suggestions will be gladly received. Send them to the Technical Editor, POPULAR SCIENCE MONTHLY, *381 Fourth Avenue, New York, N. Y.*

1. A piston type pump should not need priming if the piston is gas-tight and the valves the same, unless the pump is used to take water out of a well and is a considerable distance above the level of the water. In such a case, the air in the pump, being elastic, may expand sufficiently on the suction stroke, because of the back pressure, to prevent opening the intake valve. If the cylinder is filled with water this cannot happen because water is not elastic. A centrifugal pump has to be primed if it is above the level of the water surface from which the supply is drawn, because no force is developed unless water is rotated by the vanes of the pump.

2. A steam locomotive is what is known as a prime mover. It develops mechanical power directly from fuel. It must, therefore, carry with it the power generating plant—that is, the boiler and the supply of coal. An electric locomotive, on the other hand, is simply a machine for transforming electrical energy into mechanical power, so that from a theoretical standpoint it should be possible to build a more powerful electric locomotive than steam locomotive within the weight limits that the track will stand. The practical limit is the horsepower required to handle the freight trains it is desired to pull. When it becomes practical to handle heavier and longer trains than are now being drawn, more powerful locomotives of either the steam or electric types can be designed to handle them.

3. Calculating the possible theoretical horsepower that could be developed from any waterfall is relatively simple. The area of the water actually moving over the fall is estimated or approximated by measurement. The speed of the water motion and the height of the fall also are measured. From these figures can be determined the weight of water that drops down the falls per minute, and the theoretical horsepower is determined from this figure, since it is known that a weight of 33,000 pounds dropping one foot in one minute is equivalent to one horsepower.

4. A tiny electric motor no bigger than an ordinary grapefruit may develop a quarter horsepower and equal in power another motor weighing fifty pounds and as big as a large watermelon. The little motor develops the power by rotating its armature at tremendously high speed, whereas the bigger motor would be rated for slower speed operation. In general, for any given horsepower output the speed at which the motor must run to develop this output determines the size of the motor.

5. A vacuum is not necessary to the operation of a steam engine, but if the exhaust steam is led into a condenser where it encounters a spray of cold water it will condense and the pressure will drop considerably below the sixteen pounds per square inch which represents normal atmospheric pressure. Since this is the pressure on the side of the steam engine piston opposite to that against which the steam pressure is exerting its force, reducing the exhaust pressure adds that much to the effective pressure of the steam and raises the efficiency of the engine.

6. A chain block (Continued on page 156)

Here Are Correct Answers to Questions on Page 48

(Continued from page 155)

in its simplest form consists of a single toothed pulley to which the lifting hook is attached and a double toothed pulley attached to the hook that is to be applied to the beam or other support above. The two upper pulleys are side by side and of slightly different diameter. One side of the chain from the lower pulley is brought around the smaller upper pulley, and the other sid of the chain from the lower pulley is brought around the larger upper pulley. For each complete rotation of the upper pair of pulleys the lower pulley is raised or lowered the difference in their two circumferences. If they are very close to the same diameter a tremendous pull can be exerted because the loose loop of chain must move through a great distance to raise the object very little.

7. The draft in a chimney is caused by the difference in the weight of the column of gas in the chimney as compared with the weight of an equal volume of air at ordinary temperature. Hot air or heated gases are expanded and are therefore much lighter than cool air. Consequently the gases in the chimney do not balance the pressure of the atmosphere at the bottom of the chimney opening and air continually flows in, to become heated in turn and its weight changed. The draft or flow of air up the chimney is maintained so long as the air or gas inside the chimney is hotter than the air outside the chimney.

8. If the motor boat is of the ordinary displacement type—that is, not a hydroplane—the power required to double the speed is roughly four times. Thus if a six-horsepower engine will drive the boat at six miles an hour a twenty-four horsepower engine probably would be required to drive it twelve miles an hour. The rule is not fixed, but varies with the speed, the shape of the hull, and many other factors.

9. If you hit a water pipe with a hammer a clanking sound will be produced. Water, being incompressible, acts like a hammer when the valve is suddenly shut. The flowing water rams against the closed valve and rattles the pipe as though it were a solid metal rod.

Sees Chance of Creating Life Artificially

LIVING matter created synthetically in a test tube is predicted as a future possibility by Dr. Paul R. Heyl, physicist of the United States Bureau of Standards.

Recent advances in the ability of chemists to duplicate nature's substances, he says, are bringing this hope nearer. The first organic compound, a substance known as urea, was created synthetically as long ago as 1828 by a German chemist named Wöhler. Since then more and more progress has been made in duplicating natural compounds. A short time ago H. Fischer, a chemist of Munich, Germany, succeeded in making artificially what is known as the "respiration ferment," the substance in the blood that aids the transfer of oxygen for life processes from the red corpuscles to the tissues.

"I think we are now within 'shouting distance' of making protoplasm, of which living things are made," Dr. Heyl declares. "When that is done, it remains to be seen whether our artificial protoplasm is dead or alive." There is nothing mysterious, occult, or supernatural about any process of life, Dr. Heyl says, and the so-called "spark of life" may turn out to be a simple chemical or physical process. Eventually, he predicts, all life processes will be as thoroughly understood as is the way that oxygen helps the burning of coal.

PATENTS

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Flying with an Airship Captain

(*Continued from page 41*)

twenty-nine were safe and fourteen dead. Our noninflammable helium undoubtedly accounts for the many survivors.

With up-to-date weather service, an airship is extremely unlikely to run into such a storm; but even if it should, I think the *Los Angeles* and future ships would have a good chance to weather it. And I expect future airships will have less to fear from storms of any kind, for increasing strength goes with larger size.

Lightning is popularly regarded as a terror to airships—but that is a fallacy. Even hydrogen-filled dirigibles have often been struck by lightning with no more damage than a small hole fused in the metal bow cap. The metallic frame absorbs the electricity. I know only one authentic case of an airship destroyed by lightning—a German ship that was valving off hydrogen in a thunderstorm when lightning ignited the escaping gas and set the ship afire. The *Graf Zeppelin,* leaving Japan on its round-the-world flight, skirted a severe lightning storm without fear of damage.

A HELIUM-FILLED ship such as the *Los Angeles* is virtually immune. As an additional precaution, the parts of the metal frame are carefully "bonded" or connected together so that no small spark, induced by lightning, could set fire to the gasoline. To test it, the entire hangar is darkened and electricity at ten or twenty thousand volts is applied to the frame. Sparks instantly reveal any loose connections. This was done to the *Shenandoah* when it was built at Lakehurst, and the *Los Angeles* had the same test in Germany.

An airship flying at night carries running lights just as an ocean liner does—but double the number. That is so that other aircraft can see her and tell her heading. The wisdom of this was demonstrated one moonlight night when the *Los Angeles* was flying between Philadelphia and Trenton, N. J. Out of the darkness a mail plane came roaring directly at the ship. None too soon the pilot spotted the lights and swerved out of the way.

In a collision an airplane would no doubt suffer more than the airship. At most such a crash might puncture the envelope and rupture a gas cell or two, but there would be plenty of reserve buoyancy to make port. The airplane would undoubtedly fall, a total wreck. The reason an airship is hard to force down is that the lifting gas is carried in separate cells inside the outer envelope, just as a steamer is built with water-tight compartments.

ONE of the questions asked most frequently is what a dirigible commander would do if he ran out of fuel and no mooring place was near. In that case he would "free balloon" the ship—that is, fly it as a balloon and drift with the wind—to an emergency landing spot. Over the landing place, he would valve gas to bring the ship down, and check its fall near the ground by dropping ballast. For a landing place he would either choose the lee of a patch of woods or land the ship squarely on top of a grove of small trees. German airship men tell of landing wartime Zeppelins, out of fuel on the way back to their bases, on top of scrubby trees until a new fuel supply could be put aboard.

I think the roughest airship cruising I have ever done has been over the mountains in the southwestern part of the country, both in the *Shenandoah* and the *Graf Zeppelin.* When strong lateral gusts strike, an airship may roll a little from side to side as a surface ship does. Unlike an ocean liner however, an airship seldom lists more than an angle of three or four degrees. I have never seen anyone seasick on an airship.

Occasionally minor repairs are made in flight—patching a (*Continued on page 159*)

Flying with an Airship Captain

(Continued from page 158)

line, a rod, or a tear in the fabric. One of the most difficult repairs effected in flight was fixing the torn upper fin of the *Shenandoah* on a trip to St. Louis, in September, 1923. It was necessary to send three or four men to work in a cramped, dangerous position on the inside. A slip might have sent one of them plunging through the cover.

On one flight we did have a "man overboard" scare. We had taken up a party of civilians, and were flying high when someone reported a large hole in the envelope at the after end of the ship beside the catwalk that runs the length of the interior. We were relieved to find the civilian who had punched the hole still aboard. He had gone exploring aft, and put a foot through the envelope into thin air. It hurt neither the ship nor him, but it did give him the thrill of his life.

THE best illustration of the way that an airship is flown, to my mind, is the fact that fog does not disturb us in the least. An airship navigates, not solely by landmarks, but by instruments. The altimeter tells us we are a safe distance from the earth. A magnetic or gyro compass reports our direction, and the air speed is known from an air speed meter. We measure the drift by sighting on a point on the surface of the earth; or, if we are at sea, by dropping a flare that ignites when it strikes the water. It spouts smoke and flame for five minutes and serves as a point of reference.

Even an airplane pilot will see instruments that are new to him in the control room of an airship. One is a "gas pressure alarm." When an airship rises, the lifting gas in the cells expands because of reduced atmospheric pressure. Automatic safety valves release it before the accumulated interior gas pressure would burst the cells. At the so-called "pressure height" where the safety valves are about to operate, the alarm rings a bell and lights a light in the control cabin. If the commander does not want to lose helium gas, he immediately checks the ship's ascent.

In the daytime the sun's radiant heat raises the temperature of the gas in the cells above that of the surrounding air, and increases its lift—despite the fabric of the gas cells, a foot of air space, and the envelope with its reflecting layer of two coats of aluminum "dope," or paint. We call this temperature difference "superheat." It is important for a dirigible commander to know it, so that he can avoid valving off gas to hold the ship down when the setting sun will soon make it heavy again—or dropping ballast, during the night, when the ship will tend to rise of its own accord in the morning. He reads this important temperature difference from a "superheat meter" that the United States Bureau of Standards helped the Navy to perfect. At the touch of a switch it gives the "superheat" directly in degrees, at either the forward or after end of the ship.

DESPITE the wide impression that an airship usually comes down by releasing its lifting gas, the normal way of landing the *Los Angeles* after a trip is to fly it right in. Heading into the wind, the motors are slowed until the ship is nearly stationary and then ropes are dropped to the ground crew. They haul us down by main force against the buoyancy of the ship. Occasionally some of the ground crew get a shower bath when the ship, coming down too fast, checks its fall by releasing a little of its water ballast.

The *Los Angeles* provides an impromptu fireworks display when it lands at a mooring mast. She carries a Very light pistol, of possible use as a distress signal but principally used in the mooring maneuver. When the main cable is dropped we fire a (Continued on page 160)

Flying with an Airship Captain

(Continued from page 159)

white star. Dropping the starboard yaw wire is accompanied by a green star, and the port yaw wire by a red one. This calls attention to the dropping of the wires, which may be difficult to see, particularly at night. The ground crew respond with the same lights as they couple each wire to the corresponding ground wire. The Very lights are used both day and night, and the brilliant colored balls are easily seen in broad daylight.

When landing in fog—as just a few weeks ago—the ship sometimes is brought down slowly by valving gas. It is a little ticklish, but usually there are holes in the fog through which the earth can be seen and the landing cable dropped. Abroad there was developed a way of marking the landing field by captive balloons tethered just above the fog layer. Whistles sounded or guns fired at interval often help when landing a ship in the fog.

BRINGING an airship into its harbor has one big difference from guiding an ocean liner home. There is no "harbor pilot" who takes responsibility for the maneuver. The mooring officer, on the ground, directs both the take-off and the landing, but the responsibility for the safety of the airship belongs to the captain alone. If the maneuver does not suit him, he can step in and give orders at any time.

It is a weighty responsibility, but few dirigible commanders would care to be relieved of it. There is a majesty about such a ship as the *Los Angeles* that those who have looked at her in her hangar know. Taking this great ship through the clouds is a thrill that comes to few men. For all her bulk, she is a graceful, responsive ship of the air—the forerunner of even greater liners of the future.

"Smoke Ball" May Account for Ball Lightning

MANY are the stories of balls of fire that enter houses during lightning storms, are reported to roll or float about, and often at the end explode with a loud report and lingering smell described as "sulphurous." Unfortunately such phenomena have a way of happening, if at all, when no scientist is around to observe them. The following account, therefore, of an experience of Professor George Winchester, Rutgers University physicist, given in a recent issue of *Science*, was especially interesting. It describes another strange phenomenon which offers some resemblance to ball lightning, observed when the writer was motoring recently with his brother near Peoria, Ill.

"Just as we were ascending a gentle slope a very brilliant lightning flash occurred . . . about six feet from the trunk of a hedge tree at our right we observed a ball of smoke about two feet from the ground. The ball appeared to be about eighteen inches in diameter and perfectly spherical. The color of this smoke, if it was smoke, was a yellowish brown. We could not find even a withered twig or leaf. We raised the question of whether this "ball of smoke" would have been a "ball of fire" if the phenomenon had taken place after dark."

What caused this strange ball? According to a hypothesis suggested by a British chemist, E. Kilburn-Scott, to account for ball lightning, a bolt of lightning might possibly form a concentrated globe of semiliquefied nitric oxide gas formed by the combination of elements in the air through the action of the electric spark. Such a gaseous ball would be of such a density that it would gravitate slowly to earth. It might be luminous at light, not so by day. Most significant, its outer layer would undoubtedly react with the air, giving off brown fumes of a color like that described by Prof. Winchester.

The Truth about Hypnotism

(Continued from page 28)

diseased can be hypnotized to some extent; but apparently not more than twenty-five per-cent can with comparative ease be put into the so-called somnambulistic state, in which the most extreme phenomena are easily produced.

Psychologists are not agreed as to just what makes some persons better subjects than others. Certainly the ability to be hypnotized is not a sign of weakness, lack of "will power," or lack of intelligence. Some studies indicate that easily hypnotized persons are those who are "strong-willed" and not easily open to suggestion in everyday life. And persons can be hypnotized "against their wills" under certain conditions.

WHO can hypnotize? The ability demands no unusual powers. It is simply a matter of learning how. Some hypnotists, through study and experience, become more successful than others, just as some surgeons become more skillful than others. Nearly anyone who has watched the process, especially if he has also learned about it by being himself hypnotized, can get some results in hypnotizing others. This is unfortunate, since those who lack proper insight into the nature of the hypnotic condition may be tempted to practice on others without foreseeing possible dangers. Licensed physicians and accredited psychologists are the only ones who should attempt to hypnotize.

Is hypnosis dangerous? In the hands of properly trained psychologists and physicians, no. There is no justification, however, for the use of hypnosis for entertainment. Unskilled amateurs might do all sorts of injury to their subjects. To produce exciting hallucinations and emotions in the subject might be harmful. An unscrupulous hypnotizer might take advantage of a subject in various ways, though the subject probably could not be forced to commit actual crime, at least unless he were already a criminal. Moreover, unless care were taken to arouse the subject completely from the hypnotic state, and eventually to bring about recall of the hypnotic state, a habit of amnesia might be established which would possibly make the subject susceptible to later nervous disorders. If certain precautions are taken this danger may be avoided.

IF HYPNOSIS is of such a serious nature, why hypnotize at all? There are certain justifiable uses. One is as an anesthetic. In 1837 a certain Dr. Oudet extracted a tooth painlessly under what we should now call hypnotic anesthesia. In the 1840's surgeons, including James Braid, an English physician who coined the term "hypnotism" from a Greek word meaning sleep, employed a similar method for surgical operations and for the relief of pain in disease. Before the discovery of chemical anesthetics, hypnotic anesthesia might well have been employed more widely than it was, had the medical profession been less skeptical. This was before the common acceptance of hypnosis, about 1880. But now ether, novocaine, and other anesthetics, easier to administer and more certain in their action on all patients, have rendered the anesthetic use of hypnosis unnecessary. Even major operations might be performed, entirely painlessly, under hypnotic anesthesia. It is interesting that this is so, but ordinarily not practical.

On two occasions I have coöperated with dentists, inducing hypnotic anesthesia while they have performed dental operations, filling and extracting of teeth without pain for the patient; but I do not recommend it, for there is no need of it. Worthwhile possibilities, however, lie in the use of hypnotic anesthesia for obstetrical purposes, and in cases of painful, incurable dis- (Continued on page 162)

A definite program for getting ahead financially will be found on page four of this issue.

The Truth about Hypnotism

(*Continued from page 161*)

eases, such as cancer, that are beyond surgical treatment, to alleviate pain without drugs, but of course not to cure. Thus far, little has actually been done along these lines.

Again, there is a general therapeutic use of hypnosis by specialists in the treatment of nervous diseases, and by psychologists cooperating with physicians. Many so-called shell-shock cases in the World War were cured by hypnosis. In many nervous diseases called functional, there is no destruction of nerve tissue, yet the patient is really incapacitated. He may suffer from blindness, deafness, paralysis, headaches, indigestion, amnesia, and a host of serious illnesses without organic basis. Psychotherapy, along with proper medical treatment, is needed in such cases, and in some conditions hypnosis is the best method. One psychologist used hypnosis to restore to a World War veteran memory for his identity after an amnesia lasting nearly ten years. Not long ago I had among my students one who had suffered for over four years from a constant headache following an injury when he fell on a fencing foil, the point of which pierced the eye socket above one eyeball. There was no apparent injury to the eyeball or optic nerve; but from the time of the accident there was blindness in the eye and a constant headache, such as one might imagine would occur if a steel point actually were penetrating the skull. The best of ordinary medical treatment had failed to restore the sight or to stop the headache. One hypnotic treatment stopped the headache. The blindness in the one eye still remains with clinical indications at present that the optic nerve is really impaired; but in many similar cases functional blindness has been cured by hypnosis.

IN 1923 a World War veteran, also a student in one of my classes, came to me for treatment for paralysis of one side of the face, a condition which had persisted since the war, and which physicians assured him was functional. Before he left my office after the first treatment by hypnosis, he was able to whistle for the first time since the war, and to smile with both sides of his face.

Such cases are relatively infrequent, however. And hypnosis, psychoanalysis, and other forms of psychotherapy, though needed in the treatment of some kinds of disorders, are in general time-consuming and for this reason more expensive than ordinary medical and surgical treatment. By the method of psychoanalysis many months are often needed for adequate treatment, and with hypnosis there have been cases of successful results only after 100 or even 500 treatments. Sometimes the patients who most need such treatment are very difficult to put into the hypnotic state.

THIRD, there is the experimental and instructional use of hypnosis by psychologists in the study of abnormal psychology. Demonstrations can be made of a wide variety of the unusual conditions of consciousness and behavior, of hallucinations, paralyses, double personalities, and the like. Subconscious processes, of which the main part of the personality is unaware, may be produced experimentally and controlled.

The experimental demonstration of the reality of subconscious intellectual operations first occurred in 1886. In 1901 William James, whose name is outstanding in the history of American psychology, referred to this demonstration as the basis of the most important discovery in psychology since he had been a student of the subject. The nature of the experiment was as follows: The subject would be put into the hypnotic state. A problem of some sort, often a mathematical problem, would be given

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The Truth about Hypnotism

(Continued from page 162)

to him. Then the subject would be awakened instantly from hypnosis, before the problem could be solved. The subject then would be in his normal state, without memory even of the fact that a problem had been given. But when a ouija board was given to him, the answer to the problem would be spelled out, the subject being unaware of what it was all about. Nowadays such an experiment usually is varied, as by the use of an ordinary pencil instead of the ouija board. Then we obtain what is called automatic writing—writing which is independent of voluntary control or even awareness, but produces words, sentences, and even long compositions such as would ordinarily require conscious, voluntary control. It is thus an excellent demonstration of subconscious processes.

Hypnosis is a useful method of initiating automatic writing, but the latter may come about independently of hypnosis. Some persons find themselves able to write whole volumes of prose or poetry by means of the ouija board (automatic spelling) or by automatic writing with a pencil. A woman in St. Louis has published several volumes, the composition of which has occurred in this way. Being unaware of any participation in the authorship, and lacking psychological insight into the matter, she ascribes the authorship to the disembodied spirit of a woman, Patience Worth, supposed to have lived long ago. By experiments involving hypnosis and automatic writing, such feats may be duplicated in principle, in simple form, without need of "summoning spirits from the vasty deep" for their explanation. The source of such composition is the spontaneous expression of a submerged fraction of a person's personality.

NOR is it a rare and difficult feat to produce automatic writing. In group experiments with my classes in recent years I have been able to initiate it by a technique resembling hypnosis in about twenty-five percent of the class members. In one such experiment in 1925, for example, I asked the members of the class to think of some childhood Christmas scene. One member soon wrote, without any awareness of what he was writing (I quote with a change of name): "Sally Ann Jones. Skates. Tree." This meant nothing to the subject when he came to read it. Two months later I asked him to come to my office. I used hypnosis simply to the extent of closing his eyes so that he could not see his hand as it was writing. He took a pencil in his hand, and when told that he would write unconsciously an explanation of the previous writing, the following writing at once was forthcoming (again I quote with a change of the name of the town): "Eh, I remember that was my nurse who cared for me when I had the measles in Valley Ridge, New Jersey. She told me she would give me a pair of skates when I recovered. I got them at Xmas time. I was five years old when I had the measles. She was tall and blonde and was very pretty. She was the daughter of a manufacturer in Valley Ridge, and was engaged to be married. Her beau used to come over to see her quite often. He used to bring me candy and things to play with."

The subject was not aware that his hand was writing, and later when he read what had been written, it meant nothing to him, since he had forgotten the incident described. Consultation with his parents, however, verified the accuracy of the writing. This subject was a healthy college student, a member of the football team.

Experiments of this kind are useful in "debunking" many superstitions, in "taking the spirits out of spiritism," in showing that unusual processes like automatic writing may actually occur without requiring anything occult or "psychic" for their explanation.

Threads That Swing 350,000 Tons

(Continued from page 25)

spinning of these strands into the cables of the Hudson Bridge, is now under way. It will be completed next October. To manage it, two temporary footbridges each twenty-five feet wide had to be slung from one anchorage to another, a feat in itself.

The cables for the footbridges were the first to cross the river. They were fastened, first, to their anchorage on the New York shore. Then a barge, towed slowly across the river by tugs, paid out the cable from reels. Unwinding, it lay on the river bed where it would not interfere with passing steamers. Once across, the ropes were firmly fixed to the Jersey anchorages. Then cranes on the bridge towers reached down and hoisted the long steel cables to saddles on the tops.

The same afternoon that the first cables for the footbridges spanned the river, there was lively discussion among the workmen—a hard-boiled, rollicking, fearless lot—as to who would have the honor of being the first to cross. A supervising engineer looked down one of the shining steel ropes and saw what looked like two buzzards roosting 400 feet out. They moved—and the engineer recognized them as two of his star workmen suspended on the naked wires 250 feet above the water.

"We're crossing to Jersey!" they replied to his outraged hail. Threatened with instant dismissal, they returned to wait for the footbridges.

WITH the footbridges in place, the spinning job began. To spin a single cable, which consists of sixty-one strands, each made of 434 wires about the thickness of a lead pencil, a traveling wheel makes 26,474 trips across the river. It unrolls the wire from a reel fixed on one of the anchorages, and lays each successive wire next to the last. When a spool of wire gives out, wire from a new spool is spliced on. Completing a strand of sixty-one wires, the next wire is spliced on in the same way. Thus the wires in a main cable will consist of a single unbroken filament. When finished, the four main cables of the bridge will contain 107,000 miles of wire, enough to wrap four times around the earth at the equator.

A zinc coat protects the wire from the weather. When all the wires of a main cable have been spun, a traveling machine crosses the footbridge, squeezing them together under enormous pressure into a compact three-foot circular cable.

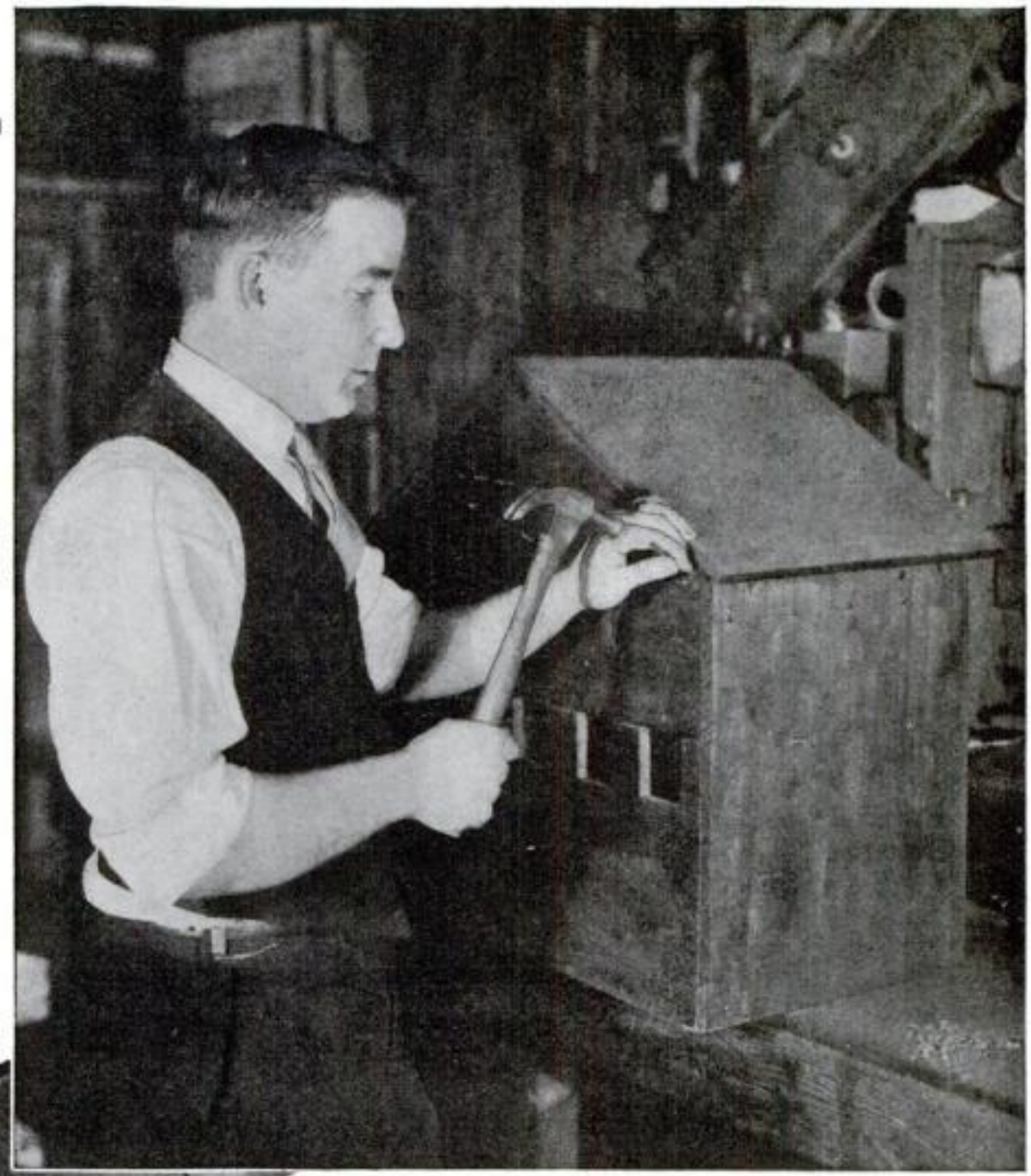
Thus the cables will support a road in the air, 200 feet above high water. They will last as long as the bridge, which has been designed as nearly permanent as engineers know how to make it, and they afford another striking example of the power of cables put to work for civilization.

Stage Scenery of Paper

THE cost of stage scenery has been reduced from thousands of dollars to thousands of cents at the Grand Theatre in Geneva, Switzerland, by an ingenious method of substituting paper for wood and other more expensive compositions ordinarily used in the fabrication of scenery. This innovation is said to have made possible the production of a musical revue at a cost under one hundred dollars.

Brightly colored paper, chemically treated to make it relatively fireproof, and of a transparency that allows the creation of novel lighting effects from behind and from in front, comprise the new scenery. It has the advantages of being extraordinarily light and easy to handle. Authorities report that the scenery for a short musical production offered between the acts at the Geneva theatre could be packed in two ordinary traveler's trunks, and cost less than fifty dollars.

Build it with a MAYDOLE



Telephone tables, ship models, garden trellises, chicken coops—any job is easier with a Maydole.

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3507

The First Pneumatic Tire—Invented to Please a Boy

(Continued from page 44)

The inventions which now require the bulk of pneumatic tires—the automobile, the motorcycle, and the airplane—were yet to become common.

After the success of the tricycle, Dunlop made a larger pair of wheels and fitted them with his air-filled tires. They were attached to a bicycle frame which had been built at a local shop. On this new machine, Johnnie "scorched" along the roads near Dublin to his heart's content.

When Dunlop tried to interest the leading cycle maker of Ireland in his tires, the head of the company, knowing the wheels were homemade, said they must be "rum" wheels.

"They will beat anything you have made," Dunlop told him.

"That is something I would rather see than hear about," was his answer.

"Come around tomorrow, and we will show you," Dunlop's invited.

The next day the cycle maker, formerly a professional racer, rode up to the veterinary's house on a shining new machine of the latest pattern, with trim, hard-rubber "shoestring" tires. Johnnie appeared on his bespattered, homemade machine with its bulging, "freak" tubes, and they started down the longest stretch of macadam in Dublin. The racing man bent over his handlebars trying vainly to keep up with the flying Johnnie. When they returned, he was puffing and admitted his defeat.

THE racer immediately ordered a pair of the tires for a new bicycle he was building. Soon afterwards, he was riding this machine home to dinner when he rounded a corner at Castle Place at such a clip that the policeman cautioned him for exceeding the speed limit.

Soon racers in various parts of the country were asking for pneumatic tires. Dunlop engaged an assistant, writing specifications for the tires on the board wall facing the workman's bench. Even after the demand for the new tires increased, the public still scoffed. The chief Irish cycling magazine dismissed Dunlop's invention with: "Pneumatic . . . sounds like 'news-room-attic' . . . bah!" An Edinburgh rubber firm declined to fill Dunlop's order for rubber tubes because it did not want "to become a party to one of the most impractical ideas ever proposed."

To advertise his invention, Dunlop went about giving demonstrations, rolling and dropping the tires to show how they would absorb vibration and withstand shocks. At last he obtained financial backing and a company was formed.

BECAUSE of their many wrappings of canvas and rubber, the first Dunlop tires were called "mummies." When they were punctured, the outer canvas jacket had to be cut open with scissors, the tube pulled out and fixed, and the jacket sewed up again. Once when the inventor was taking a vacation near his birthplace in Scotland, he met a dejected cyclist trundling his machine, with a flat tire, along the road. He did not know how to fix the puncture. Dunlop climbed down from his buggy and did it for him. When the cyclist learned who his helper was, he declared he would keep that tire always as a souvenir.

In later years, Dunlop, unfortunate in business dealings, felt he never received full credit or financial reward for his invention. However, when he died in 1921, at the age of eighty-two, millions of people were enjoying comforts which they would have lacked but for this man whom a member of Parliament called "that plodding and success-deserving Scot."

There's Many a Place for Plastic Wood

Plastic Wood placed in a caster socket will hold the loose caster fast and firm.

Handles Like Putty

Hardens Into Wood

When hard it is waterproof and greaseproof, takes paint, lacquer or varnish perfectly, can be worked with tools, and adheres lastingly to any base. Plastic Wood is an invaluable aid to the upkeep of the home.

For wood rot use Plastic Wood and save expensive replacements.

Cracks around the baseboard can be quickly and permanently filled with Plastic Wood.

Plastic Wood is the ideal filler for replacing bathroom fixtures and loose tiles.

Many a toy accident can be permanently repaired with Plastic Wood.

Shelving and cabinets can be made insect proof and dust proof by sealing any cracks with Plastic Wood.

Before replacing screws fill the old holes with Plastic Wood to hold the screws fast.

Plastic Wood is carried by Hardware and Paint Stores, and comes in handy household tubes at 25 cents; ¼ lb. cans at 35 cents and 1 lb. cans at $1.00. Plastic Wood Solvent, to soften or to thin Plastic Wood and to clean the hands or tools after using, is sold in 25-cent and 50-cent cans.

For loose rungs, gouged or chipped furniture, Plastic Wood is a repair kit in itself.

Manufactured by Addison-Leslie Company, 325 Bolivar Street, Canton, Mass.

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A vast majority of radio engineers use Alcoa Aluminum for variable condenser blades, because the blades themselves must be perfectly flat, must also be perfectly uniform in thickness—they must not vary the width of a split hair, if you are to get knife-edge selectivity, clear, sweet tone.

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Look for Alcoa Aluminum variable condenser blades in the set you buy—also Alcoa Aluminum foil condensers, shielding, wire and other parts. It is your assurance that the manufacturer has selected the most efficient material.

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Merely flow the color on

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"Rogers" levels itself. Forms a smooth, colorful coating over old or new surfaces.

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